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ARE YOU EDUCATED IN SCIENCE

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You have studied science. Has it contributed to your education? Have you obtained some understanding and interpretation of the wondrous natural world in which you live? Thomas Huxley describes his school instruction in science as follows:

> What is a horse? The horse is termed equus caballus; belongs to the class mammalia; order, pachydermata; family, solidungula.

Science has failed to educate if it has provided you only with such useless baggage. Do you know the flowers of your community? Do you know the most common birds and the most common trees? Are you at home or just an unwelcome guest among the inhabitants of the great outdoors? Do God's free creatures pass the time of day with you? Do you have any confidants in the starry heavens? Do you dispose of mysterious natural phenomena merely with the exclamation, "That beats all"? Science for much of the universe should have rolled back the veil of mystery and yet have preserved the romance. You should understand the function of pistil and stamen in the fertilization of flowers; why a small girl can steer a large car; why coal is found in veins; why in winter alcohol is used in radiators; why it is easy to swim in salt water; why rain, hail, and snow differ in form; why a balloon rises; why the moon is luminous. Science should have revealed to you nature's laws, and should have made you a companion of God's creatures.

You should know about the applications of science to the affairs of men. Science has been the angel of health. When his wife and baby died, Hiawatha believed the Great Spirit disapproved the part of the stream where the family lived. You know that a polluted stream may cause typhoid. You know that men do not die of brain fever

because they work their brains too hard, or of appendicitis because of fruit stones in the "cherry pouch." You know that "internal inflammation" was once a category to cover a multitude of ailments. You know that cold baths are not dangerous and that night air is not poisonous. You know that much of woman's traditional fainting was feinting. You know the influence of psychological suggestion upon physical health. You recognize the folly of intermittent bleeding as formerly practiced. Science has in terms of health made a new world for man. Science has greatly increased man's birth expectancy and reduced infant mortality. Science releases man from the obligation in his infancy to contract all children's diseases. Science has fortified man in his youth against diphtheria, typhoid, and tuberculosis; and now offers some prevention and protection against heart disease and cancer in his old age. Through science man lives much longer and never dies "by act of God." The individual's chances of longevity are good if he carefully selects his grandparents, inoculates himself against diseases, selects his food wisely, fraternizes with the surgeon, and has access to a pulmotor.

Science should have organized the raw forces of nature for your comfort and happiness. In many respects science has made life safer and easier. Better sewage disposal, better lighting, less smoke nuisance, better sanitation, have made life healthier and freer. The applications of science have revolutionized transportation and communication. Joseph in the Old Testament and Thomas Jefferson in 1800 had the same means of travel. The Battle of New Orleans in 1814 was fought two weeks after the treaty of Ghent had been signed. Today the giant leviathans traverse every sea. Parallel arms of steel span the continent. Human birds of the air cross the continent in ten hours. Radio messages pepper around the world. Robinson Crusoe's island has a broadcasting station. Modern science has made the world a better place in which to live.

Science has given to the world the machine age and modern industrialism. Do you know that the industrial revolution which originated in the gloomy hills of northern England has now captured all Christendom, and above all, America? Do you know that the industrial revolution did not come earlier because of the existence of human slaves? Do you know that the three parts of a machine are the engine, or prime mover; the end tool which does the work; and the device yoking the shaft to the tool? Do you know that the power age was born when man discovered how to yoke his tools to a moving crank shaft? When Faraday revealed the interchangeability of electrical and mechanical power, genii of force were unleashed, the significance of which man is yet unable to grasp. Henceforth, the dynamo

became the symbol of infinity; in estimating units of scientific force, arithmetical ratios became useless. In due and brief time rural America was transformed to a nation of factories through the five great prime movers: steam engine, steam turbine, water turbine, gasoline engine, diesel engine. Mass production, or the making of interchangeable parts, with its minimum of human labor, became the practice. Mass production became the father of "machine tending" in which the factory worker feeds, punches, jerks back; feeds, punches, jerks back. He puts in a bolt but does not put on the nut. F. W. Taylor says:

> The ideal of efficiency in industry is to simplify the work to such a degree that it can be done by a trained gorilla.

Do you know that science is the father of the Machine Age and modern industrialism?

Have you cousidered the implications of the Machine Age which science has produced? Man's arm has been lengthened. Have his heart and his nerves been steadied? A General Electric machine can bore through sixty feet of solid steel. Can man find truth, and beauty, and poetry in the machine? Does the machine contribute to the sense in man for beauty and for conduct, as Matthew Arnold would say? Does the machine refine the senses while it increases the power of human muscles? Can personality be saved in industry if men are standardized, classified, and if they are blind servants of the machine? Has the machine increased man's satisfactions? Has the pride of the artisan in a personal piece of work been forever lost? Will the machine's golden egg of increased leisure enable man to seek personal improvement outside industry? Will increased leisure be a boon or a curse? Is materialism the goal of life or merely the means? Has your education in science stimulated you to reflect on these problems?

Your education in science should have given you an appreciation of the work of great scientists and the growth of tested thought. You are familiar with Aristotle's prodigious work of classification in biology; you recall the painstaking efforts of Fabre, the fertility of Pasteur in making hypotheses, the genius of Darwin in interpreting masses of data; the open-mindedness of Galileo and Edison. Such heroic men of genius appear to excel Sherlock Holmes in cleverness, Job in patience, Lord Nelson or Bobby Jones in their ability to follow through. But no matter how intriguing the biographies of the great scientists, the growth of the scientific spirit and of ideas in science is even more fascinating.

The Greeks of course had no conception of physics or chemistry or psychology in the modern sense. They did not possess the lynx-like lens; they missed the remote of the telescope and the minute of the

microscope. Socrates and Plato confined themselves chiefly to abstract philosophy. Aristotle attempted to organize and classify all objects in natural science, and to speculate as to the remainder of the universe. Under the prestige of his *ipse dixit* his biological code and Aristotelian philosophy became *a priori* the guide of life. Among thinkers this dominion was unbroken for almost two thousand years. Controversial issues were settled with, "What does Aristotle say?" If Aristotle had no comment, the subject was not worth while.

But one fine day in 1590 a courageous soul, Galileo, dropped two balls of different weight from the leaning tower of Pisa. Contrary to Aristotle, the balls fell side by side. Some professors of the University of Pisa preferred still to believe Aristotle, but time vindicated Galileo. One shivers under the significance for thought of Galileo's experiment. A new principle in physics had been proclaimed; a new method in logic or science had been originated, that of tested thought. It is tested thought which distinguishes the modern world from the mediaeval and ancient. Professor Whitehead has said:

> Not since a babe was born in a manger has so great a thing made so small a stir.

Inspired seeker for truth, Galileo fought a good fight against ignorance and tradition. He invented a telescope and discovered spots on the sun despite the opposition of a sage who said:

> Don't be alarmed. I have read Aristotle through three times and nowhere does he mention spots on the sun.

Galileo suffered the scourge of the Inquisition, was imprisoned in his old age for differing with Aristotle and Moses and the Theologians. When compelled to repeat the seven penitential psalms and to deny that the earth moves around the sun, he arose from his penitential knees and exclaimed:

> Nevertheless, it does move.

Here was a true scientist. The world was different after Galileo.

Copernicus weakened man's historical smugness. He showed that the earth was not the largest of the planets, and that man was not the center of the universe as he had proudly assumed. His revelation of the solar system and its operation mark him as the father of modern astronomy. The world was different after Galileo and Copernicus. Disciples of Galileo and Copernicus saw themselves on a new earth surrounded by new heavens. Aristotle's astronomy and physics became almost worthless. Almost all scientific baggage had to be rejected. The epoch produced Francis Bacon, the father of modern science, the formulator of the inductive method. Bacon, Galileo, Descartes, had to construct from the bottom up. By repudiation of the

old metaphysics, they provided a new stimulus to all thought. During the next one-hundred years, seekers for truth sought to establish the most elementary facts for the new science. Harvey carefully scrutinized hen's eggs and became the father of embryology. Newton became interested in an apple and unlike Adam was rewarded by discovery of universal gravitation and the laws of motion. Workers learned how to measure time, temperature, and atmospheric pressure; they developed the telescope and microscope; they tampered with lenses and tubes, pulleys and wheels; they experimented with worms and frogs. They established the basic facts of modern science.

Do you realize what a potent factor modern science has been in separating the modern world from the mediaeval and ancient? Watt with the steam engine and Faraday with the dynamo broke the back of the Middle Ages and launched the Industrial Revolution. Into the re-made society have gone the contributions of the Fultons, Fords, Stevensons, Cartwrights, Wrights, Bells, Edisons, and scores of others. In the nineteenth century, Helmholtz announced his conservation of energy, and Pasteur his germ theory. In 1859 Darwin published his *Origin of Species* and proclaimed his theory of biological evolution. Another milestone had been reached in the progress of the race and of man's thought. In the language of William James, Darwin had taken the lid off the universe. Not only must science be reconstructed but philosophy, all social sciences, and religion. Modern psychology was born. The world was different after Darwin. Man lived in a world of staggering problems. To add to the confusion, Madame Curie discovered radium and raised the question as to whether matter and motion were not one, contrary to the fundamental tenets of orthodox science. Today Einstein dilates on relativity. We are informed that Euclidean geometry is obsolete; that parallel lines will meet; that Newton was wrong about the apple, and Helmholtz about the conservation of energy. In such confusion, we are continuously peppered by cosmic rays while we learn about the production of gamma rays. Incidentally, thanks to the success of Copernicus, we find that each atom has a solar system of its own, containing numerous protons and electrons.

If you have been educated by science you should be able to make generalizations in the field of science. You recognize that Greece did not advance further in science because of the lack of a lens; that slavery hindered Greek inventiveness. You should recognize that Aristotelian metaphysics and ecclesiastical dogma greatly retarded the growth of physical science. It should be clear that modern science began with Galileo, and Copernicus and Bacon. Watt's relation to the Industrial Revolution should be evident. Watt's engine, and Faraday's dynamo, and Madame Curie's radium should be symbols of the

illimitable force in man's physical world. The modern lens should be recognized as a key to a world so remote and minute as to defy the natural senses. In terms of physical comfort and happiness you should recognize mankind's debt to Pasteur and Edison. You should grasp the general implications for science of such generalizations as: gravitation, conservation of energy, relativity, Copernican system, evolution, radio-activity, Euclidean geometry, atomic theory, mechanical theory of the universe.

Finally, your education in science is fragmentary and inadequate unless you have gained a scientific attitude, a scientific way of looking at life. The scientific attitude reduced to lowest terms means an intelligent and impersonal search for truth. One with a scientific attitude possesses integrity, patience, and thoroughness. Democritus revealed the scientific attitude when he said:

> Rather would I discover the reason for a single fact than become the king of the Persians.

An old Chinese proverb says:

> When you know, to know that you know; and when you do not know, to know that you do not know,—that is true knowledge.

It is indeed the scientific attitude. The scientific attitude senses problems, sets up hypotheses. It is eager to discover new truth; it is skeptical of aged formulae. It seeks to reduce the number of mysteries. It places no faith in superstition. The scientific attitude recognizes that science cannot solve all problems. Science cannot tell us what the values of life are, what the good life is. Science must ever remain not the whole but only a part of life. Science alone could never have built the cathedral at Chartres or Rheims. For the whole of life, science must be supplemented by the poetic, the artistic, and the romantic.

TEACHING AIDS CATALOGUE PUBLISHED BY WESTINGHOUSE

A new 24-page Teaching Aids Catalogue has been published by the School Service Department of the Westinghouse Electric Corporation. The catalogue describes 80 free and inexpensive charts, posters, booklets, and other audio-visual materials now available to junior and senior high school teachers.

These teaching aids cover numerous subjects, including atomic energy, jet propulsion, electricity, radio, television, nutrition, home freezing, laundering, lighting, electric motors, and social studies. Information is offered also on the Westinghouse Five Year Replacement Plan for School Appliances, Lighting the School Plant, and Westinghouse Scholarships available to students and teachers.

Each catalogue contains order blanks for use in requesting the materials desired.

Teachers can obtain copies of the Teaching Aids Catalogue (B-4743) by writing to the School Service Department, Westinghouse Electric Corporation, 306 Fourth Avenue, Box 1017, Pittsburgh 30, Pa.

RADAR COORDINATE DATA FOR ANTI-AIRCRAFT GUNLAYING*

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The position of an aircraft at P in space is located with respect to the observer at O (Fig. 1) by the three coordinates X, Y, and H or by the polar coordinate system A (azimuth), E (elevation), and D (slant range).

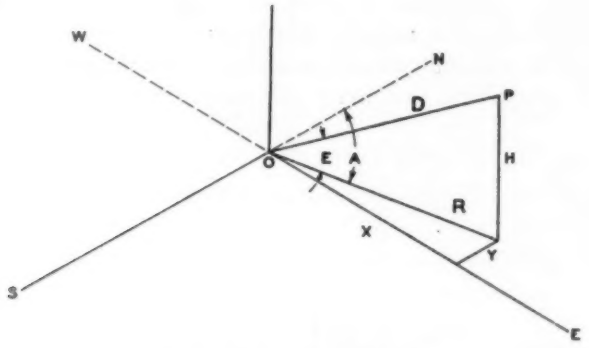

FIG. 1. Space Coordinates.

One computing device developed during World War II requires continuous present position data in the form of X, Y, and H in order to position the guns so that the trajectory of the projectile and the path of the moving target will intersect at the instant F seconds (fuse time) after firing.

How can these present position data be obtained? When the target is visible, the direction (angles A and E) can be easily obtained and the range (D) can be obtained by a range finder similar to that used on a camera. The chief difficulty encountered in this method is that the errors involved increase directly with the range. Aside from the precision, this method is predicated on visibility which thus becomes the real limiting factor.

The development of high frequency radar (radio detection and range) using short pulse duration, together with timing techniques and automatic tracking devices, offered the possibility of obtaining present position data from an unseen aircraft. The range determination is based on the time required for a transmitted pulse to reach the target and the reflected echo to return. Errors involved are independent of the range. (The precision of measurement of slant range

* Drawings prepared by William H. Howe, a first year engineering student.

is of the order of 20 yards on one gunlaying radar set widely used during the war.)

It is emphasized that the radar set does only two things, (1) track the target and (2) transmit continuous present position data to the computing device. While the problem of automatic tracking is an interesting one and there are some good applications of trigonometry in its accomplishment, this brief treatment will deal only with the obtaining of the three elements of present position data X, Y, and H.

In one type of range presentation a circular time base is used (see Fig. 2). The time elapsing between the transmitted pulse and the received echo is indicated in yards of range on the circular scale. By a gear system this angular displacement is transferred to the movable arm of a linear wound precision potentiometer. One of the terminals is at ground potential and the other is kept at $+160V$.

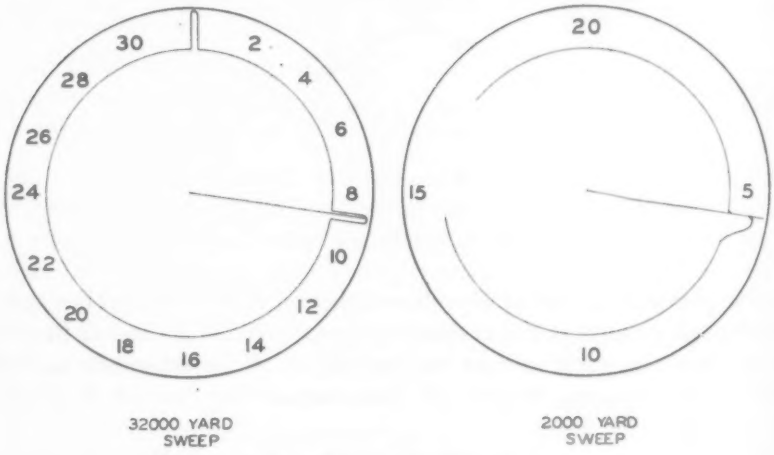

FIG. 2. Range Presentation.

Hence the movable arm of this potentiometer taps off a voltage between 0 and 160 depending on its position. Since 32,000 yards is the maximum range, any observed range D, determines the position of the potentiometer arm so that the voltage tapped off is $(D/32{,}000) \times 160$ volts $= D/200$ volts. Throughout the system 200 yards are represented by 1 volt, or 1 yard is represented by 5 millivolts. Thus the range D to a moving target is continuously available as a d.c. voltage.

Now since X, Y, and H are the desired coordinates, it is necessary to determine the d. c. voltages representing these distances. Reference to Fig. 1 shows H and R as legs of the right triangle whose hypotenuse is D. The voltage representing D has to be multiplied by the sine of E to obtain the voltage R. This is accomplished by impressing the

voltage D across an elevation potentiometer which consists of two circular resistance cards, one "sine wound" and the other "cosine wound."

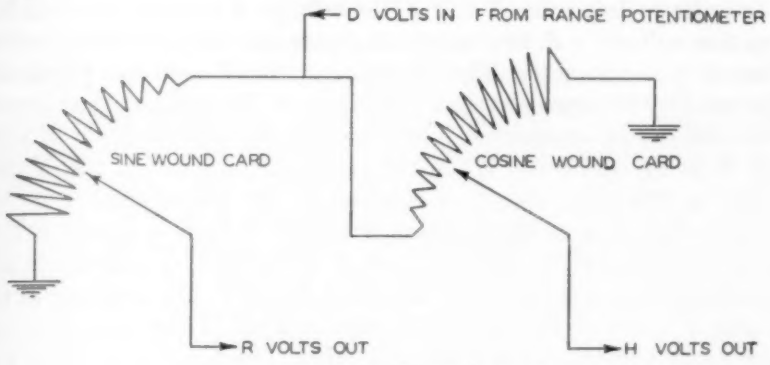

FIG. 3. Elevation Potentiometer.

The position of the variable arms of these potentiometers is determined by the angle of elevation (E) of the parabolic reflector. The sine potentiometer in effect multiplies the voltage D by the sine of E

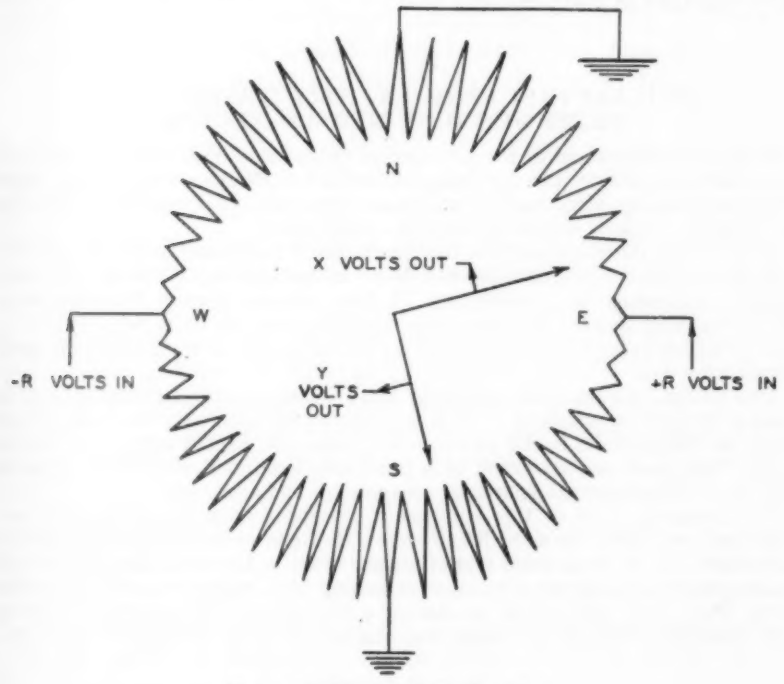

FIG. 4. Azimuth Potentiometer.

thus giving the voltage representing H. Likewise the cosine potentiometer multiplies the voltage D by the cosine of E giving the voltage

R. The potentiometer cards have many turns of fine wire and are so designed that the resistance of the winding is proportional to the sine (or cosine) of the angular displacement of the movable arm.

In order to determine X and Y, the voltage R and also an equal but negative voltage $-R$, are impressed across the sine and cosine wound azimuth potentiometer. The X arm and the Y arm are physically separated by 90 degrees as shown in Figure 4. The two points at ground potential can be considered North and South, with East at R volts and West at $-R$ volts. When the radar set is oriented the X arm points in the same direction relative to the potentiometer as the compass direction of the antenna reflector. Thus it is apparent that for any position of the antenna, two d. c. voltages, of magnitude and direction corresponding to the distances X and Y, are available at the X and Y arms of the azimuth potentiometer. These two arms are necessarily well insulated from each other. The polarity of the X and Y voltages may be negative or positive depending on the direction of the target.

Thus the three rectangular coordinates are available and continuously sent to the computer as d. c. voltages, with the proportionality constant of 200 yards per volt.

AIR POLLUTION FROM FACTORY WASTES EASILY DETERMINED BY NEW COLLECTOR

Dangerous substances in the air, such as those sometimes found near certain manufacturing plants, can be easily collected for analysis with a new device developed here by Mine Safety Appliances Company. It is usable also in mines and highway tunnels where air pollution often exists.

It is a timely development now that the public is awakened to the dangers that may come from air pollution from modern manufacturing methods. The smog tragedy at Donora, Pa., which took 21 lives, greatly hurried this awakening. Among the first users of this new sampling equipment were the men of the U. S. Public Health Service who reported their investigations of the Donora air conditions a year ago.

This device utilizes what scientists know as electrostatic precipitation. Air passing through a sampling tube is bombarded by electrons from an ionizing electrode. All particles in the air are given a negative electric charge by the electrons. Then they are attracted to a positively grounded aluminum collecting tube. In the laboratory the particles are removed and analyzed.

The sampling head of this equipment, weighing only four pounds, is self-contained and resembles a small hair-dryer. In the head is a blower that provides a constant flow of three cubic feet of air per minute. The head also contains the ionizing electrode and the aluminum collecting tube which fits around the electrode. Power is by cable from an electric outlet or portable generator. The current is rectified through a voltage doubling circuit using two electronic tubes.

The National Safety Council says that according to state reports about one-sixth of all drivers involved in fatal accidents had been drinking and one-fourth of all adult pedestrians killed in motor-vehicle accidents had been drinking.

FIELD TRIPS—A METHOD OF VITALIZING TEACHING

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Field trips, if properly planned and conducted, can prove to be a most interesting and instructive method of teaching boys and girls, and one which leads children to make actual application of their learnings. Field trips offer respite from straight textbook learning, yet there are few things which will be so adequate to instill a desire for more textbook usage, a more concentrated study and a better understanding in some subject area. A field trip is one of the best means of integrating subjects. Field trips also provide opportunities for introducing a unit of work, teaching a concept, or summarizing material studied in a given unit.

The seasonal changes in colder climates make it impossible to take all types of field trips throughout the school term, but this same seasonal change provides an opportunity to study a variety of situations, each typical of a particular climatic condition. In autumn one may study the principles and laws of reproduction through maturation and dispersal of seeds, or through animals such as fish by visiting a salmon fish hatchery. Other principles which may be studied by autumnal field trips are: the adaptive processes of plants and animals through their preparation for winter, principles and laws connected with weather and climate, and concepts such as freezing, dewpoint, rainfall, and the classification of clouds. In the social science area trips to manufacturing plants and historical landmarks of various types near the community bring out principles of economy and sociology. Winter in southern climates provides opportunities for a continued study of many of these principles and concepts. In the higher altitudes and northern lattiudes limitations of study of many of the principles and concepts are brought on by the weather. But certain animals and birds are with us the year 'round, and by providing a little food for them on sticks or just outside the window on the snow the children can enjoy and study these animals all winter. Principles such as dependence of animals on man, adaptation to the environment, concepts concerning the relation of plants and animals to successful wintering, can be studied. In the spring there is an almost unlimited choice of areas for possible study. Projects started in the fall for continuation in the spring should be completed. Melted snows and spring floods suggest the study of principles governing control

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of water, erosion of soils, study of plants and foods (chemicals) needed to make them grow, the reproduction of plants through blossoms. Lumbering, making maple syrup, farming, the effects of winter on wild life, are all possible subjects for spring field trips in science, social studies and art.

Integration of subjects should be kept in mind when planning a field trip. In some cases a teacher may be able to build an entire year's work or a complete course around a series of field trips which began with a definite theme. For example, such a theme could be "The Work of Water" and could integrate many subjects. Perhaps a series of five field trips would be taken to study principles and concepts concerning: (1) types of soils and the relationship of plants and animals to soils, (2) erosion, sedimentation, and the formation of deltas, (3) uses of water for power, city water supply, irrigation, and industry, (4) types of valleys—young, old, and geological formations and relationship to erosion, (5) the effects of the stream upon the lives of the inhabitants of the locality. From this it is not difficult to see how geology, biology, sociology, and economics enter the picture through this series of field trips. On the spot and back in the classroom the students have an opportunity to describe what they see, thus using penmanship, oral and written communication, creative dramatics, art, and music.

If a field trip is to be really successful, it must be carefully planned and executed. The class should be prepared for the trip, and it should grow out of their interest so that they will be ready and anxious to take the trip. The trip should grow out of the interest in some area which the pupils are studying and should serve to answer questions in this area for the boys and girls.

Before any field trip is taken with a group of children, the teacher should consider all possible places, determining which is best from the standpoint of accessibility and also from the standpoint of how explicitly the area demonstrates the principles and concepts to be taught. Is the area accessible for the age group taking the trip? Can the group walk, or is it possible to obtain transportation? Which location provides the desired number of stations for discussion? Can the trip be taken within the time limits imposed by the schedule, or, if more time is needed, can arrangements be made without interfering with other classes? It is a necessity to always secure the permission of the owner or caretaker before bringing a group for a field trip. This should be done even when the trip is to a public place such as a park or museum.

If the children want to take the field trip, they will likely participate to good advantage in the planning of it. With a little guidance they will plan to care for safety factors on the trip, will also suggest

things for which to look, and articles to collect and bring back to the classroom. A discussion of things to collect will almost inevitably result in planning for the necessary equipment for the trip, and the type of clothing to be worn. Because of factors involving safety, it is generally unwise to take a trip with boys and girls of the lower or middle elementary grades which would endanger the clothing they usually wear to school.

During the planning session the children, with a little guidance, will recognize the need for some group organization and the need for discipline. They will recognize that others in the building who are not taking the trip with them deserve consideration, and that extra noise while leaving and reentering the school building will disturb their activities. It is highly desirable that leaders be selected to lead the group to the first and perhaps to subsequent stations. It is just as important and as great a responsibility to be the "rear-guard." If autos are used for transportation and there are more than three, it is well to provide identification of autos. A definite color of cloth tied to the rear bumper is a great help in identifying a member car, particularly if the route leads through traffic. The last auto in the line should be equipped to care for minor emergencies, such as flat tires, engine trouble, etc. If this is done, it follows that its occupants should be the best mechanics. Occupants of the first auto should know the route and the exact stopping place. If the route is circuitous, the leader should stop and wait until all cars have arrived at the intersections which could be confusing.

Once on location, instruction should begin. Many situations indicate the best procedure is to give the children a minute or two to look around and to discover and collect items they decided upon collecting for the classroom, but the group should be under control at all times. At a given signal, sometimes prearranged, the group should be called around the instructor. At each of the planned stations the instructor should carefully consider the position of the group so that the children are not annoyed by the sun shining in their eyes, and so the instructor need not talk against the wind. In most cases the instructor will have to decide upon a compromise to make the best of a situation. All too frequently the instructor gathers the children about him. This is generally poor procedure because inevitably there will be some children behind the teacher and some too far to the side to observe and hear all that is said. With groups of older children it is wise to stand in front of the group, and if possible, have some small barrier such as a stump between you and them.

Good teaching calls for participation by the majority of the students. In the field a teacher has boys and girls in as nearly perfect a teaching situation as is possible. They usually respond to leading

questions better than do adults because they are less self-conscious. A few carefully planned questions will stimulate student participation in recognizing and discussing problems. With a little guidance, students will ask and answer each other's questions, interpreting observations and relating them to important principles and connected concepts.

All of us feel that we should get everything possible out of a trip. This over-zealous attitude is often responsible for the failure of a field trip which would otherwise be most successful. What is the optimum number of concepts to be taught on any one trip? This number is dependent upon the teacher, the individual members of the class, and their interest in the material to be covered by the trip, but experience shows that from five to seven concepts is the maximum for adults. Children seem able to learn three or four concepts and through discussion show they have considerable mastery of the ideas and their relationship to each other.

The number of stations used on a particular field trip may vary, but usually two to four stations will provide opportunity to observe, collect materials, and discuss the three or more concepts you desire to teach. More stations are likely to result either in needless repetition, or in an attempt to teach more than the individual child can assimilate. While still on the scene, and perhaps at the last station, it may be wise to have a student summarize the concepts learned. At the same time it is well to point out the correlation of the various concepts to our society and to show how they are interrelated in various fields so that the students may carry these concepts in their broadest relationship back to the classrooom with them. If students show lack of understanding or want to see the things again, you might retrace the path to the stations for more emphasis.

Returning to the classroom brings with it problems of discipline. The boys and girls may be full of energy and ideas, or they may be physically tired. There is usually at least one "wiggle worm" who will cause a commotion. Just as regard for the right of others was necessary while leaving the building and while on the trip, so it is necessary upon returning to the classroom. This discipline need not and should not come as a demand of the teacher, but should be recognized by the students as a part of their responsibility in taking the trip and can be planned and discussed when the rest of the trip is planned.

Once back in the classroom, discussion of the field trip must be continued. Discussion of the things observed serves to help teach communication. There should be opportunity to express through art and music the children's interpretation of what they have seen. Certainly, more reading in the area covered by the trip should be a natural outcome. Pupils should be permitted to read silently for more

information and also aloud to the group when they find something they think will be of interest to the other members of the class. Writing about the trip in story or news form gives experience in penmanship and written communication. Mathematics can usually be used in the trip too, perhaps to calculate population of plants, animals, or insects, perhaps by computing the amount of water which might soak into the ground and the amount which runs off. Even the measurement of erosion requires the use of arithmetic as a means to an end rather than the end itself. Or perhaps the children will decide to make a model of the site or sites observed, and in this case, arithmetic and creative art are taught. Science and social science, because of their very nature, being needed to explain the observations and to help solve any problems of a biological and physical science nature, cannot be excluded.

Course work and interpretation of natural phenomena will not be the only outcomes of any one field trip. In discussions the instructor should be able to encourage children to probe the existing knowledge in a particular area and to gain ideas for new areas of study, suggesting other field trips. Thus the field trip summarizes old concepts, and by their use in actual situations, teaches new concepts and the power of observation and thinking, and develops new areas of activity and interest for the children, making their school life real, vital, and above all, interesting.

MEASURE VELOCITY OF WATER BY HIGH PITCHED SOUND WAVES

The velocity of water in the discharge from turbines in hydroelectric plants may be measured by passing sound waves in the ultrasonic region through the water, the American Institute of Electrical Engineers was told here today.

The method of using ultrasonics for this purpose was described by W. B. Hess and S. K. Waldorf of Safe Harbor, Pa., Water and Power Corporation, and R. C. Swengel of York, Pa. They presented the results of tests made with a small duct, five by nine inches in cross section, with water velocities up to six feet per second.

The ultrasonic method, they declared, appears to have distinct advantages over existing methods of measuring the discharge of turbines in large hydroelectric stations. In carrying the method to the present state of development a great many difficulties have been overcome. It now appears that remaining difficulties may be overcome and the method applied to large scale measurements.

This method of using sound waves too high-pitched to be recognized by the human ear consists essentially of calculating water velicity from the measured phase angle between the transmitted ultrasonic signal and the signal received after passing through the body of moving water, they stated.

Instruments to pick up the sound waves after they passed through the water were placed on the wall of the water duct opposite the transmitter and "displaced some definite distance along the principal axis of flow." From this the phase angle was determined. Errors of less than two percent were obtained in measurements in the test duct.

FARM LIFE IN A BIG CITY

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A study of one's food and clothing will reveal the fact that many of them are the products of the farm and of farm life. Meat, milk, fruits, vegetables and grains are grown or produced outside the city on tracts of land cultivated or adapted to their specific needs. Fibers for the cloth and hides for the leather of our clothing are products of the soil from which seventy-five per cent of the world's business is transacted. The farmer who is responsible for the production of crops and livestock is a skilled workman in the cultivation of the soil, in the care of growing plants and animals, in the use and maintenance of machinery and in fighting insects and disease. Farming is not only a means of livelihood but because of the unique aspects of living in the country, it is also a way of life. Upon the farm and upon farm life the people of the city are dependent.

Important as is the farm and farm life in supplying many human needs one is surprised how ignorant and misinformed city youth are about them. The misconceptions and lack of understanding of a group of city high school seniors were revealed on a tour of a diversified farm. Dry cow "chips" were mistaken for fungus growths, cows were identified as bulls because they had horns, field corn was thought to be sweet corn and for the first time a bull pen was something other than a warm up place for a relief pitcher.

Further shortcomings of city youth were revealed by the discussions in the Farm Life club of our high school. A pupil giving a report on food mentioned that pork chops came from cows. The process of weaning was confused with wieners. Mention was made of a "female cow." When a club member asked the meaning of sow, the pupil giving the report on swine replied, "A woman pig." Pupils inquired whether cows were born with horns and what time of day chickens laid their eggs. The young people in general had little comprehension of the existence of breeds of livestock.

After a study of the environment and educational background of high school students one is not surprised at their ignorance of farm life. The city zoos and plant conservatories contain, to a large extent, the exotic, the unfamiliar animals and plants from distant places. Periodically the city press carries stories of bus loads of children being taken thirty to fifty miles into the country to visit farms to see the animals, crops and farm activities. These trips emphasize the neglect of the park officials to provide for that vital aspect of education which is an acquaintance with the source of one's food and clothing.

High school activities and surroundings reveal little about farm life to city youth. Biology laboratories contain few plants and animals of agricultural importance. Instructors are highly trained in the academic aspects of life but are often unfamiliar with the plants and animals which furnish much of our food and clothing. A possessor of an M.A. degree in biology was asked if he had ever seen a bull heifer. He was acquainted with them! School facilities and instruction are much concerned with the foundation principles of animal and plant life but are little concerned about the superstructure which arises above them.

The shortcomings of university biology courses in imparting practical information about farm life was brought home to the writer when he travelled to a western state university to study courses in economic botany and heredity. In neither course was a trip of any kind made outside the classroom although the farm and countryside were not far distant. Long hours were spent in drawing and labelling the fruits of plants and in figuring out the colors and shapes of offspring from different colored and shaped parents. How the plants grew to maturity was never discussed although their place and time of origin was methodically pointed out. The great improvements in our domestic livestock and food plants due to scientific breeding were unmentioned.

The failure of the school and of public park officials to effectively provide knowledge of the farm to city dwellers has led the writer to explore the resources of a large city for farm life material and experiences. Somehow, somewhere, and in some degree the things which are important about the farm may be discovered nearby. Though widely scattered and dispersed over the four seasons of the year there may be much of farm life that can be ferreted out for observation and study. The writer in his study of farm life has evolved a plan to provide conveniently and permanently for farm exhibits and activities in the midst of bustling and seething city life.

A trip to the zoo reveals a few interesting farm animals and their distant relatives. Muscovy ducks, the females of which are quackless, are common inhabitants in the bird sanctuary. The Easter bunnies for the little children are represented by New Zealand rabbits. These rabbits are popular on the farm for both meat and fur. Since the fur is white it can easily be dyed any color and shade. The Red Jungle Fowl from East India are the chickens of the zoo. From these are derived all our domestic breeds of fowl. The zoo cattle are the Yak and the Zebu. Under the name of Brahman the Zebu cattle were introduced into the U. S. White Zebu bulls are considered sacred by the Brahman caste of India who associate the animals with Brahma, Hindu divinity.

The plant conservatories contain many plants of economic impor-

tance, some of which are grown on the farm. Cotton plants may be seen at certain times of the year. The plants grow to a height of about three feet and are distinguished by the snow white bolls of cotton. Lemon and orange trees bearing fruit present a strange sight in the latitude of Chicago. The Ponderosa lemon attains a weight of three pounds and could be grown commercially except that they are too big to be in demand.

Two of our museums contain a wealth of material relative to the farm. The Chicago Museum of Natural History has specimens or replicas of practically all of our farm fruits, vegetables, grains and fibers. There are many beautiful murals upon walls and colored pictures upon glass of primitive and modern agriculture. The Museum of Science and Industry has a wonderful exhibit of a farm including a "dream" farm house, dairy barn, milk house, blacksmith shop, chicken brooder house, "fields" and "meadows." The dairy barn contains specimens of the major breeds of dairy cattle. The air is filled with the sounds of cows mooing, pigs grunting and birds singing. Here are exhibits of primitive and modern farm machinery and dioramas of the great moments in the history of agriculture. Many days may be spent in these museums studying agriculture when outside the earth is covered deep with snow.

A morning spent on the grounds of the union stockyards brings one in view of many of the breeds of the larger farm animals. Almost any day one can see the three common types of beef cattle: the Aberdeen Angus, the Shorthorn and the Hereford. A representative of the Brahman breed is so rare as to be unusual. The five major breeds of dairy cattle, Ayrshire, Brown Swiss, Holstein-Friesian, Guernsey and Jersey are usually represented in a day's shipment to the yards. At the chutes from which there is no return, all breeds of swine plunge ahead of the "slapper" to the disassembly line and pork products.

Part of the drama of packingtown is to see the transfer of ownership from the commission man who represents the farmer to the buyer who represents the meat packer. On a morning in July of 1950 the cattle prices were "steady." The commission man asked thirty and one-half cents a pound for seven "good-to-choice" steers. The buyer bid twenty-nine cents, then thirty cents but the seller was firm. It looked like a stalemate until the buyer bid thirty-and-a-quarter cents for six steers and twenty-nine cents for the seventh steer which was "not-so-good" and the deal was closed.

Farmers who have come to town to sell their livestock often join the guided tour of packingtown. In joining the tour a city dweller has the opportunity of speaking with farm people in addition to seeing the animals slaughtered and dismembered. Before the beef reaches the consumer's table, it is cut by forty-eight workmen using twenty-

two kinds of knives into four hundred and sixty-four pieces. Hogs are knifed at the rate of six hundred an hour and within twenty-eight minutes the carcasses are cleaned inside and outside and ready for the cooler. At the end of the tour one can see the meat, fresh and smoked, which is the chief product of long months of planning, feeding, caring for and transporting which extend back to the middle western feed lot and beyond to the western ranges.

Live poultry stores found in many neighborhoods exhibit an ever-changing assortment of farm poultry. Usually on hand are Rhode Island Red, Barred and White Plymouth Rocks and White Leghorn hens which had proved to be boarders that did not earn their keep. The aged roosters in the group had been found unsuitable for breeding purposes. During the holiday seasons, the store inventories are swelled with numbers of Bronze turkeys, Embden and Toulouse geese and Pekin ducks.

Many city dwellers have contact with a farm through an acquaintance, friend or relative by which they are able to purchase farm fresh eggs. In the event that the eggs are farm-run, i.e. unassorted, every dozen of eggs is a surprise assortment. The egg sizes may vary from jumbo to small and the shapes may be conventional, long and narrow or short and round. The shells may be white, brown or speckled in color and smooth, pimpled or rippled in texture. Opening the eggs is an adventure in itself for there may be one yolk, frequently two, infrequently three or more or none at all. A few stores sell double yolked eggs by the dozen to those who like a larger proportion of yolk to white.

The modern stream-lined fruit and vegetable store and the green grocery section of a chain store are splendid places to acquaint one with edible plant products. Every day of the year fruits and vegetables locally produced or shipped in by train, truck, boat and plane are available for study (and for sale). One's own reading and experiential resources may be supplemented by information from the fruit and vegetable clerk. On a hot listless day in August the clerk remarked that his watermelons were grown in Florida and weighed as much as forty-eight pounds.

Many farm newspapers, journals and magazines are found in the libraries of the city, perhaps not so much in the neighborhood as in the regional and downtown libraries. These are sources of useful and up-to-date information on farm equipment and practices. Many of the articles give an insight into rural living, recreation, handicraft and philosophy. The "letters" column brings one close to the people of the land. A farm woman wrote of her boy having for a pet a 2500 pound Holstein bull. When her boy started the old "Chevy" to go to town, the bull would often jump into the bed of the truck for the ride.

Colored pictures of farm life are abundant in farm journals and nature magazines. These pictures may serve as the means of identifying the different plants and animals in town and country. The National Geographic magazine has wonderful articles devoted to vegetables, cattle, bees, insects, chickens and other farmyard poultry. A trip to a used magazine store in search of these issues is as exciting as a treasure hunt. If you locate your sought after copies on the counter or open shelves they may be had for ten to twenty cents each. If you ask for them and get them from the "file," the price is fifty cents to a dollar and seventy-five cents!

Within the city and on its outskirts are farmers' markets where produce is sold directly from producer to consumer. The presence of washed carrots, radishes and lettuce indicates that the farmer has learned something from chain store merchandising. Here one can often see products not ordinarily available at retail stores. Such products include parsley roots, thyme and other herbs, elderberries, black walnuts and cut flowers from "old fashioned" gardens. The farmers' prices are not much different from regular retail prices for farmers have learned to keep up with the market by reports from newspaper and radio.

The home vegetable garden has not quite given way to the spacious lawn with flowered borders. The impetus given by the war to vegetable gardening still accounts for many planted areas on vacant lots. Snap beans, carrots, beets, lettuce, parsley, radishes, spinach, onions and tomatoes are popular favorites for the city garden. The city garden being small is easily watered by hose or can and is not dependent for its survival on nature's downpour as is the truck garden.

There are within our city frequent shows of agricultural interest. In 1948 a county fair was held here for the first time. Within easy reach by street car and bus, the best in farm animals, plants and equipment could be seen. This year a prominent feature of the Chicago Fair was an exhibit by one of the local meat packing companies. A Brangus bull, Brahman cow with her calf, a Texas Longhorn steer, grass fed and corn fed cattle, lard and bacon type hogs and the different breeds of sheep formed a wonderfully complete collection of the larger farm meat animals. The International Livestock Exposition held yearly in Chicago is considered the "World Series" in meat livestock competition. Flower and vegetable shows in the late summer or early fall are often featured in the plant conservatories.

However, for a convenient, year round, permanently located place of agricultural interest, a farm center according to figure 1 would be ideal. A complete exhibit of farm animals with descriptive and informative placards would be the center of attraction. Following the example of the "Zoo for the Little Ones" in Paris, bottles of milk might

be sold for hand feeding to the pigs. Plots of ground planted with our major farm crops would acquaint the city dweller with food plants as they exist naturally during their entire period of growth.

A museum would be an essential part of the farm center for models of agricultural machinery, temporary and permanent exhibits of farm products, and for farm handicraft. Many of the farm implement companies make small models of their products which would find a place here. Other exhibits would include an egg weighing scale and a candler, a gourd water dipper, an old-fashioned butter churn, milking stool, cradle sickle, soil testing kit, milk and cream testing outfit, dairy cattle horns collection and a picture gallery of men famous for agricultural achievement. The museum structure itself might simulate a modern farm building.

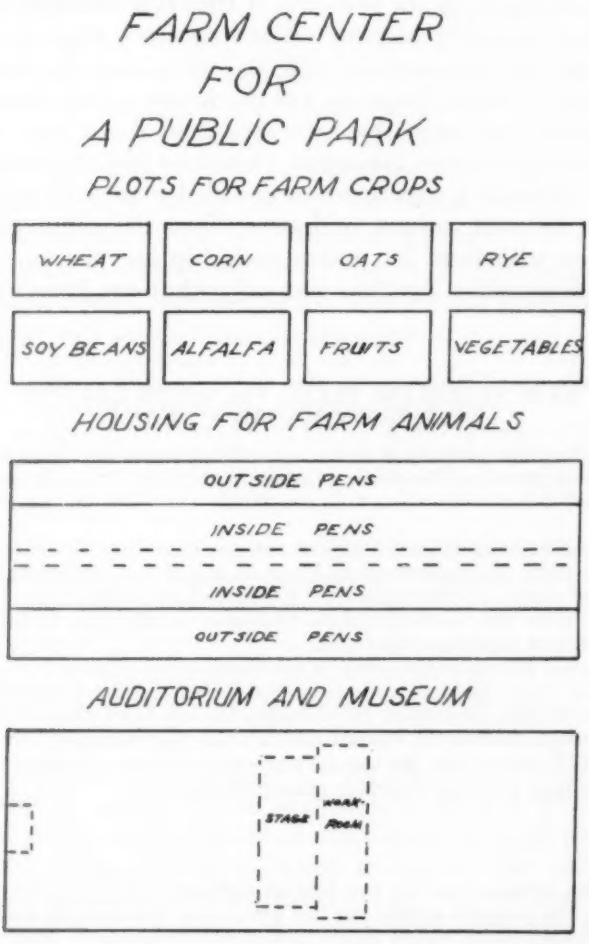

FIG. 1

The auditorium would be used for farm demonstrations such as those given by 4-H club members and also used for recreational purposes. Soil testing, soap making, egg candling, pig vaccination, cooking and farm handicraft demonstrations would be given on Saturdays, Sundays and holidays. The workroom would be convenient for preparation for a program and ready access would be had through it to the resources of the museum. The milking of the dairy cattle would be done morning and evening in the milking parlor on the rear of the stage. Motion pictures of farm activities, state fairs and agricultural celebrations might be given after a regular schedule. The floor could easily be cleared of movable benches for rural types of recreation.

Acquaintance of city people with whatever farm life is found close at hand has some desirable outcomes. They become more intelligent consumer purchasers of the products of the farm resulting in greater economy and shopping pleasure. When one sees what is behind a loaf of bread, the flour and the mill, the wheat and the shower, one is not so liable to waste the product of much care and patience extending back a year and more. Farmers appear in a new light as skilled workmen and investment managers. Delusions about starting a farm without much capital, experience or knowledge are dissipated. When city people do visit a farm or journey into the countryside their acquaintance with farm life makes their trip one of tremendous interest and observation for "one sees only what one knows."

NEW STAINLESS STEEL PROMISES LARGER TELEVISION PICTURE TUBES

Larger rectangular pictures in home television sets are promised with the development of a new stainless steel particularly suitable for use in picture tubes because it has a heat expansion rate practically the same as that of the glass screen.

TV tubes with metal sides and glass fronts are more durable than tubes of all glass and they can be constructed in larger sizes and in rectangular shape. One difficulty has been a suitable metal that will expand and contract at the same rate as the glass under the heat conditions developed in the tube. If the expansion rates are different the glass will crack.

Stainless steel is a desirable metal in television tubes because it is durable and non-corrosive. The new steel was announced here today by United States Steel Corporation. It was developed by Carnegie-Illinois Steel Corporation, a subsidiary, in cooperation with video vacuum tube manufacturers. It is an alloy containing 17% chromium. By special processes its grain structure is stabilized without changing its other desirable characteristics.

Tire alarm, attached to the tire like an ordinary valve cap, whistles a loud alarm when the pressure within the tire gets below the amount needed for safe driving. It adds another safety factor as well. Being luminous, it shows at night as a revolving circle of light.

RELATED SCIENCE AND VOCATIONAL CURRICULA

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Two vocational high schools were recently inaugurated in the Panama Canal Zone. Considering the philosophy of a vocational school, it seemed important to set up a physical science course which would consist of the science elements related to the trades. The course could then be called related science, and would be a departure from the conventional chemistry and physics offerings given in general high schools.

To attack such a problem, the first step was to find out what other vocational schools were doing in terms of related science, or in science courses given primarily for the benefit of trade students regardless of what the name of the course may be. Questionnaires were sent out to vocational high schools in forty-four states, public and private trade schools and to high schools offering some trade courses. Of the 113 questionnaires sent to the United States, eighty-two were sent back from thirty-three states resulting in a seventy-three per cent return.

The questionnaire was designed to find out the following:

1. What physical science courses are being offered?
2. What units of work make up these courses?
3. Is this material taught for the benefit of trade students or in general courses with no planned correlation to the trades?
4. How much time is spent per week in these science courses, both in class discussion and laboratory work?
5. What laboratory experiments are performed in connection with these science courses?

The results of the inquiry showed that motor mechanics, wood and metal fabrication and home economics were the most frequent vocational courses offered. The science courses given in these schools, in order of decreasing frequency, were: physics, chemistry, related science, applied physics, applied chemistry and applied science.

Assuming that the name of the course was relatively unimportant, and the work making up the course was of importance, the questionnaire also included a list of units of work which were to be checked if included in the science course offered. The units of work most frequently checked were simple mechanics (simple machines), heat and expansion, and mechanics of liquids and gases. The units of work which were least frequently checked were lubrication, protective coatings, household chemicals and the analysis of foods and drinks. Thirty per cent of the course and eighteen per cent of the units of

work were applied directly to the trades being taught in the schools. Ninety-six per cent of the schools teach physical science courses under one of the names given above.

Of interest was the response to the check list of experiments included in the questionnaire. Seventy-eight experiments were listed. About half of these can be found in any standard physics or chemistry manual for high school use. The other half of the experiments listed were those designed to be of a more functional nature such as analysis of milk and water; lubrication experiments, (flash point, carbon residue, gasoline distillation, viscosity test, etc.); analysis of foods and food tests; and others which dealt directly with the trade theory being taught in the shop or classroom. There was opportunity for the recipients of the questionnaires to check "desirable" if the experiment was not being performed (by individual students or groups of students), but seemed desirable. Approximately eighty-six per cent of the first half of the experiments were taught in "general" science courses and not for the benefit of any trade curriculum given in the school, eleven per cent were performed for the benefit of specific trades and three per cent were not being performed but seemed desirable. In the latter half of the experiment list, the functional part mentioned above, sixty-one per cent were performed in "general" science courses, fourteen per cent for specific trades and twenty-five per cent were not being used but seemed desirable. It was also noted that thirty per cent of the vocational schools studied did not have laboratory periods to supplement the class discussion.

Some of the schools responded to the inquiry by sending letters of explanation in regard to their science offerings. A few vocational schools teach none of the physical sciences; some stated that although only chemistry and physics were offered they were not intended for the trade courses; and there were other vocational high schools which stated that the shop instructors taught whatever science elements were deemed necessary as the trade course progressed, with no separate class or laboratory.

Such variation in the methods used for teaching the physical sciences to vocational students and also the varying content material in the different science courses suggests that some vocational schools are organizing their science programs to meet the needs of trade students, some are not, and some are indifferent. There apparently is no documentation to prove whether it is profitable, unwise or that it makes no difference to correlate the physical sciences with trade theory. However, suggestions for the establishment of related science courses, and statements dealing with the need for related subjects in general, have been written and published. It was from these sources of information that the following elements of science, needed for voca-

tional curricula, were found. Results from the questionnaire data were also taken into consideration.

For wood-working the following elements of science are considered necessary:

1. Expansion and contraction.
2. Lubrication.
3. Knowledge of handling plaster.
4. Metallurgy fundamentals.
5. Determining moisture content.
6. Properties of acids, bases and salts.
7. Protective coatings.
8. Properties of gases.
9. Effect of acids, bases and salts on metals.
10. The basic elements of electricity.
11. Study of simple machines.
12. Strength of materials.

For motor mechanics and metal-working the following elements of science were considered necessary:

1. Chemical changes.
2. Properties of oxygen.
3. Chemistry of water.
4. Properties of acids and bases.
5. Industrial materials (cellulose, rubber, carbon, cement, tile, etc.).
6. Paints.
7. Survey of metals used in the automotive industry—metallurgy fundamentals for metal-workers.
8. Lubrication.
9. Properties of copper.
10. Fire extinguishers.
11. The basic elements of electricity.
12. Study of simple machines, work, power.
13. Strength of materials.
14. Mechanics of liquids.
15. Mechanics of gases.

For home economics the following elements of science were considered necessary:

1. Solutions, suspensions, emulsions.
2. Solubility of gases in liquids.
3. Volatility in chemical reactions.
4. Baking powder chemistry.
5. Food and caloric values of foods.
6. Textiles and plastics.
7. Heating and ventilating.
8. Softening of water.
9. Lighting devices (electricity).
10. Principle of thermos bottle, pressure cooker, household motors, flush tank.
11. Cleaning processes.
12. Analysis of milk and water.
13. Food tests (starch, protein, etc.).
14. Metric system.

It can be seen that there is a great deal of overlapping in the four curricula mentioned. It is possible to fuse the elements of science listed for all four curricula into units of work intended for a related science course. A fifteen-unit course would result if organized in the following manner:

Units of Work	*Elements of Science Listed*	*Programs in Which Included*
1. Chemistry for the Shop	Chemical Changes Acids, Bases, Salts Fire Extinguishers Properties of Copper Properties of Oxygen Solutions, Suspensions, and Emulsions Volatility in Chemical Reactions Softening of Water	MM,* WF, MF, HE

Units of Work	*Elements of Science Listed*	*Programs in Which Included*
2. Electricity	Electricity Lighting Devices Household Motors	MM, WF, MF, HE
3. Heat and Expansion	Heat and Expansion Heating and Ventilating Thermos Bottle and Pressure Cooker	MM, WF, MF, HE
4. Lubrication	Lubrication	MM, WF, MF
5. Machines, Work, Power	Simple Machines	MM, WF, MF
6. Properties of Materials	Moisture Content Industrial Materials Plaster Metallurgy Fundamentals Strength of Materials	MM, WF, MF
7. Protective Coatings	Protective Coatings	MM, WF, MF
8. States of Matter	Mechanics of Gases Mechanics of Liquids Solubility of Gases in Liquids	MM, WF, MF, HE
9. Weights and Measures	Metric System	MM, WF, MF, HE
10. Analysis of Milk and Water	Analysis of Milk and Water	HE
11. Baking Powder Chemistry	Baking Powder Chemistry	HE
12. Cleaning Processes	Cleaning Processes	HE
13. Food and Caloric Values of Food	Food and Caloric Values of Food	HE
14. Food Tests	Food Tests (Starch, Protein, etc.)	HE
15. Textiles and Plastics	Textiles and Plastics	HE

* MM—Motor Mechanics.
WF—Wood Fabrication.
MF—Metal Fabrication.
HE—Home Economics.

The elements of science found necessary for study by trade students then resolve themselves into fifteen units of work, the total of which

can be entitled related science. It can be seen that the three shop trades would study nine units each, and the home economics students would study eleven units.

There develops the difficulty of scheduling the trade students for this particular course. However, if the above science is considered necessary for the total development of trade students, it certainly warrants a place in the program of vocational schools.

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THE TACOMA NARROWS BRIDGE

Waterproof Douglas fir plywood is helping to speed the return of "Galloping Gertie," the Tacoma Narrows Bridge which collapsed four months after completion in 1940. It will soon be back in service at the old span—this time minus the fatal gallop.

Almost a third of a million square feet of waterproof plywood is being used for concrete forms on the giant project. This was done to save time and money in the job of placing more than 4,300 cubic yards of concrete in the roadway, piers and other above-ground structures.

This use for the light and smooth panels is possible because of special waterproof adhesives, according to Monsanto Chemical Company.

Engineers of the Washington State Bridge Authority, which is constructing the mile-long span at a cost of $11 million, tested bridge models in winds up to 100 miles an hour before coming up with the final plans designed to withstand the slashing winds which whip through the funnel-like passage between Tacoma and the Olympic Peninsula.

An unusual feature of the new bridge combines aerodynamic and engineering principles. Grilled steel slots, which are designed to act in the same manner as spoiler flaps on an airplane wing, disrupt the flow of air and equalize the pressures.

Two huge hydraulic "shock absorbers" will stop any bounce or roll that the new Gertie may develop.

FEATHERING THE NEST

One of Yellowstone Park's famed black bears learned to solve the heating problem last winter, borrowing from man's knowledge of home insulation. This bear's hibernation hideout was beneath a cafeteria at Fishing Bridge. As wintering time approached, she tore out large swatches of rock wool from the building's engine room, carried the material 25 to 30 feet and lined her den with it. The warm home paid dividends—the bear came up with triplets in the spring.

INSIDE THE ATOM

II. THE AMAZING LORD RUTHERFORD

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In a small New Zealand town in 1871 was born Ernest Rutherford. He became a scientist who had a theory—indeed, he had many theories—which has been called the foundation of all our modern theories of atomic structure. Usually by the time a scientist states such an important scientific theory as Rutherford stated in 1911, he has already worked long and is ready to let other men carry on his work. Ernest Rutherford, now known to us as Lord Rutherford, because he was created a baron in 1931, was forty years old in 1911 when he first announced his theory. Few men can announce a theory and then go on to work on it, to develop it more, and finally to prove it by experiment. That is what Lord Rutherford did, and that is why many people rank him with Sir Isaac Newton who developed the law of universal gravitation and built a system of philosophy around it, and with Michael Faraday who discovered electromagnetic induction and all the associated laws, as one of the three greatest physicists who ever lived.

Lord Rutherford's early work depended upon the Curies' discovery of radium. Rutherford worked in Canada at McGill University with radium and another element, thorium, which Madame Curie had proved was very much like radium because it also gave off rays. There were different kinds of rays given off by radium and thorium. They were named *alpha rays*, *gamma rays*, and *beta rays*. Alpha rays were found to be absorbed by a layer of air a few inches thick; beta rays would pass through thin pieces of aluminum; and gamma rays would go through a piece of iron ten inches thick.

Rutherford did much work with these radioactive materials. He proved by experiment that the rays from thorium were very tiny particles. Since thorium gave off alpha rays, he called the particles of material *alpha particles*. Then he proved that alpha particles are atoms of helium bearing a positive charge, that is, having one more proton than electron. The experiment he performed to prove this makes a very interesting story.

First he placed a radioactive gas, radon, in a thin-walled glass tube. The walls of the tube were so thin that alpha particles which the gas gave off could pass right through them. Around the tube he put a tube made of thicker glass through which the alpha particles could not pass. Then he sealed two electrodes in the wall of the outer tube and filled it almost to the top with mercury. He had an arrangement by

which he could raise the level of the mercury in order to put pressure on any gas which might be trapped in the outer tube.

He took all the air out of the outer tube and let the two tubes stand for a few days. Then he raised the mercury to put pressure on the gas which he thought might be trapped in the tube. He passed an electric discharge between the two electrodes. When Rutherford analyzed it with a spectroscope, the light from the electric discharge showed all the lines of the helium spectrum.

In order to prove that the inner tube had not contained helium which had filtered through the glass into the outer tube, Rutherford filled the inner tube with pure helium gas and let it stand inside the outer tube for many days. No helium spectrum was obtained when Rutherford tested it with the spectroscope. Thus Rutherford had proved that the helium that was present in the outer tube the first time he did the experiment came from the alpha rays—in other words, that these alpha particles are really made of helium atoms.

In 1901 and 1902, Lord Rutherford worked with Frederick W. Soddy, another young scientist who had just come to McGill University as a chemist. Rutherford had needed someone who knew more about chemistry than he did to help him on the chemical side of radioactivity. These two men, working together, decided that if alpha particles are really helium atoms, and if these helium atoms are given off by some radioactive elements, then these elements must change to other elements when they lose the alpha particles. Rutherford proved that radium produces an element that is a gas, but not helium gas. He called the gaseous substance into which radium changes ***radon***. He condensed radon gas into a liquid and found that the liquid was radioactive like radium. Its radioactivity disappears within a short time, but then a solid substance which is also radioactive comes out of the liquid.

Sir William Ramsay, the Scotch chemist, measured the atomic weight of the gas that radium first produces. He found the atomic weight to be 222. The atomic weight of radium is 226. The atomic weight of helium is 4. Rutherford drew the conclusion that an atom of radium loses an atom of helium when it changes into radon.

Since radium is always giving off alpha particles, Rutherford decided that there must be a time when all of a little piece of radium had changed into radon. In order to find out how long this would be, Rutherford found the number of alpha particles given off by a certain weight of radium in a certain length of time. By a series of mathematical operations, he discovered that it would take 1600 years for half of the radium to be changed to radon. But then he found that it would take another 1600 years for half of the radium that was left to be changed to radon. So *all* of the radium would never be transformed.

Today, instead of trying to figure out how long a piece of radium will last, scientists figure out how long it will be before half of it is changed to radon. This can be done for all radioactive elements, and the figure found is called the "half-life" of the element.

Rutherford and Soddy were the first to state the laws governing the rate at which radioactive elements are transformed. They drew graphs to illustrate their laws. The time it takes an element to change to another substance, or *to decay*, appears as a curve on these graphs. When Rutherford was made a baron, his coat of arms had on it a cross made of bent lines. These lines represented the decay curves that Rutherford drew in 1902.

A few years later Rutherford figured out how much heat was given off by a piece of radium during its half-life. He discovered that a huge amount of heat, much more than men had realized, was stored in radioactive elements. This was the first time that men had imagined the great power of atomic energy, if radioactive elements could only be made to give off all at once the energy stored in them.

For almost ten years, Lord Rutherford experimented with radioactive elements. He learned in 1911 that if he directed a thin stream of alpha particles from radium at a screen of zinc sulphide, the screen would glow in the spot where the stream of alpha particles hit it. The spot of light-glow actually consists of many tiny flashes, each one produced by a single alpha particle striking a single spot on the screen. Rutherford found that if a thin foil of metal was placed between the screen and the radium which was giving off the alpha particles, the glow on the screen became bigger. When he examined the screen with a microscope, he found that not so many particles were striking the screen in a certain area as had struck it when the metal foil was not there. This made him suppose that the alpha particles were made to turn from their paths during their passage through the metal foil. He also learned to measure the angle through which the particles were deflected as a result of the foil's being there. He measured how much the angle of deflection varied when he used foils of different atomic weights and different thicknesses. He found that some of the alpha particles were deflected so much that they did not strike the screen at all, but bounced right back to where they came from. Lord Rutherford reasoned that there must be intense forces in certain places in the atoms of the metal foil to make the alpha particles behave in that way. Since each alpha particle has a positive charge, and only another positive charge can repell such a positive charge, Rutherford reasoned that these places in the atoms must be places where a great number of positive charges are clustered together.

To help us to imagine how seldom an alpha particle would just happen to come close enough to a cluster of these positive charges to

be deflected, let us blow up the alpha particles to the size of airplanes. The metal foil would then be about 600,000 miles thick—almost as thick as 100 earths placed side by side. If the clusters of positive charges were drawn to this scale, they would be something like 360 miles apart—as far apart as Washington, D. C., and Boston. The airplanes, representing alpha particles, flying at the piece of metal 600,000 miles thick, would very rarely pass near one of the clusters of positive charges as far apart as Washington and Boston. Only when they passed very near would they be deflected backwards. Most of the airplanes could pass entirely through the space without coming near any of the Washingtons or Bostons scattered 360 miles apart.

Lord Rutherford had reasoned correctly when he decided that only clusters of positive particles placed very far apart in the atomic structure of the metal foil could deflect the alpha particles backwards. Niels Bohr used Rutherford's findings to construct the theory of atomic structure for which he won the Nobel Prize in 1912. You will remember that Mr. Bohr's atom looks like our solar system. The nucleus is large and heavy like our sun. It is composed of closely packed, positively charged protons. The particles flying around the nucleus at great distances from it are much lighter and have negative charges. They are electrons, and they correspond to the planets in the solar system.

A proton is 1840 times heavier than an electron. Even so, protons can't account for the large weights of most atoms. Bohr's theory is that particles made of a combination of a proton and an electron make up the additional weight in the nucleus. These particles, as yet undiscovered when Bohr constructed his theory, he named neutrons.

Bohr could not have made his theory without Rutherford's findings. Later scientific discoveries about the atom have agreed with Bohr's theory.

After his experiments with the metal foils—his most important work—Lord Rutherford went on bombarding different elements with alpha particles. In 1919 he was aiming at nitrogen atoms with fast-moving alpha particles. He proved that sometimes protons are knocked out of the nitrogen atoms. The protons could only have come from the nuclei of the atoms since, according to Bohr's theory, only the nuclei of atoms contain protons. This meant that Rutherford had discovered a way to change the nucleus of an atom. Scientists had been able to knock electrons out of the outer orbits of atoms, but never before had they changed the nucleus. When the nucleus of the atom was changed, it meant that one element had been changed into another! In this case, Rutherford had changed nitrogen into oxygen.

The proton that left the nitrogen nucleus when that nucleus was changed to an oxygen nucleus, shot out at a great speed. Sometimes

it shot forward, and sometimes backwards. Rutherford knew that the alpha particles he was shooting at the nitrogen were not moving fast enough to give the proton that much of a push. The push that supplied the energy necessary to make the proton shoot off so fast and so far must have come from the change in the nucleus of the atom. Thus Rutherford had another hint of the tremendous energy stored in the nucleus of the atom. (The first hint had been the great amount of heat given off by radium when it changed to radon.) Later on, men were to find ways of releasing the energy of the nucleus all at once in the atomic bomb. But this development came after Rutherford's death in 1937.

Before he died, Rutherford had witnessed the development of the atom-smashing cyclotron. He had worked with many of the men who were to carry on research on the make-up of the nucleus of the atom. He had discovered many things about the nucleus of the atom which upheld and gave further proof to Bohr's theory—the one which had resulted from Rutherford's own experiments.

Rutherford died less than ten years before the first atomic bomb was dropped on Hiroshima. When he died, men were thinking more of using the radioactive elements in the medical treatment of cancer than they were of using the power stored in the nuclei of atoms. Rutherford, who was saddened by the suffering he had witnessed in Europe after the first World War, would have been disappointed that the first major result of his work was the atomic bomb.

BATTLE AGAINST INSECT RAVAGE OF FORESTS STEPPED UP

The government is stepping up its long-term battle against an enemy which ranks with fire in ruining American timberland—the forest insect.

Dr. Harvey J. MacAloney, veteran insect scientist of the Agriculture Department, was named to head a new warning network designed to spot insect outbreaks before they reach the point where, like fire, they can race out of control through valuable timber.

A Forest Insect Survey was approved by Congress in 1947. Although it is still in skeleton form, eventually the Survey hopes to cover all 48 states with a system of trained observers. These men, many working on a volunteer basis, will keep sharp eyes cocked for dangerous buildup of the tiny forest marauders.

One of the most serious of these, at present, is the spruce budworm, eating its way through a million acres of Pacific Northwest Douglas fir, white fir and spruce. Seven forest-dusting pilots were killed this summer in fighting the budworm plague, which earlier had brought ruin to 2,000,000,000 acres of forest in Alberta.

Other pests, which in some parts of the country cause damage far exceeding fire losses, include bark beetles and a host of those insects that chew the foliage of trees.

The insect network will be a weapon against fire as well. Trees which have been killed by pests are prime fire hazards.

HIGH SCHOOL BIOLOGY AND MENTAL HYGIENE

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It is increasingly apparent that our schools are becoming aware of the importance of the problem of mental adjustment in regard to high school students. It has been our observation that the subject of mental hygiene is best included in a course where an understanding of human behavior comes in a natural sequence as part of the development of the individual; moreover, *mental growth, physical growth, and emotional growth are inseparable* and should be integrated into the subject field in which these three aspects of the personality could be taught most logically. It has been our conviction that this could be done in the now existing courses of most schools. Take, for example, biology. Of course mental adjustment of pupils is not a problem for the biology teacher only but for every teacher regardless of the subject which is taught. Most individuals go through a normal sequence of development, both physiologically and mentally, and, therefore, an understanding of these processes would be an excellent way to introduce an elementary study of mental hygiene.

Basically mental hygiene and biology are related and overlapping in certain areas. If we consider that biology is the study of living organisms and mental hygiene is the adaptation of human organisms to their environment, then the basic knowledge of biology would lead to a better understanding of mental hygiene. The gradual processes involved in the evolution of various organ systems of animals, especially in relation to the increasing complexity of their nervous systems, give the students a comprehension of how man's complicated behavior probably arose. The studying of actual responses in lower organisms is important in that it gives the students an insight into the more complex behavior patterns of man. Besides giving the students a perception of behavior, it allows them to formulate their own ideas of human behavior at their respective level of development. The whole idea of mental hygiene is new to most students and by correlating this material to something already learned the study of mental health would become more real and interesting. For example, if a student can see how an ameba adapts itself to its environment by means of differing responses in receiving various types of stimuli, then this comparative type of teaching could be used in several animal phyla to portray the increasingly complicated types of responses shown in higher organisms. Moreover, in those schools where there is no physiology or psychology in the curriculum, health is an important phase of any biology course. Human health, in its physiological aspects, is adequately covered

in most biology courses; our most recent textbooks give ample evidence of this fact. But what about the question of mental health?

Most recent textbooks in biology are almost devoid of material on mental health. To be sure, most biology texts abound in materials on ecology, but the important problem seems to be how to relate this material to the experiences of the student in terms of mental hygiene. The idea of relating animal and plant adaptation to human adaptation is not a new idea but it certainly could be of more practical use in mental hygiene. There have been many studies made which show that facts by themselves are of little value to the student, and unless there is some direct use made of these facts, there is no functional learning. It is our contention that the student correlate biological facts with psychological facts. Thus two goals are reached at the same time, (1) a knowledge of biology, and (2) a knowledge of mental hygiene. In other words, the student uses biological facts previously learned to understand human behavior.

The sophomore year of high school would seem to be the best time to give the student some insight into his particular problems in terms of his age group, because they are of major importance to the student at this time. A good place for the introduction of mental hygiene would be after a study of the physiology and anatomy of the nervous system and sense organs. It would be a natural step from a study of the nervous system to individual adjustment in terms of the nervous system. Of course, in all discussions of this type, one can not omit the socio-psychobiological implications; in fact, they should be discussed simultaneously with the psychobiological mechanisms. When insects are studied, the individual insect is studied first to acquire some general facts, then later these learnings can be used to interpret facts regarding other insects and to formulate some ideas about insect behavior in terms of the individual responses within the group. In other words, mental hygiene has to be simplified so that the student can understand some of his own immediate problems if the objectives are to be successful. Heretofore, it has been apparent that the physiology and anatomy of the individual has been stressed without giving along with these an understanding of the mental and emotional growth of the individual in his environment.

In Theodore Reik's book, *Listening with the Third Ear*, he says, "Schools now teach boys and girls anatomy and biology, but no one teaches them that the psychology of the sexes is different, that men and women go differently about the business of living and loving. The images and thoughts which the adolescent boy and girl connect with the words are not the same."[1]

[1] Theodore Reik, *Listening with the Third Ear*, New York: Farrar Straus and Co., 1949, p 92.

Dr. Milton Rosenbaum of the University of Cincinnati on his twelve point program for mental hygiene says in his sixth point, "In the schools: Raise even higher the standards for teachers, with emphasis on the emotional capacity of the teacher to handle children and on the teacher's training in human behavior and group psychology. At the same time, teach mental hygiene courses to the youngsters."[2]

Some have said that mental hygiene is a problem for the guidance director or counselor. It is difficult to agree with this statement because all students at the adolescent age need the assurance and understanding that others have the same mental difficulties as they themselves have. Furthermore, if in discussion of these difficulties the reasons are explained in terms of the individual's experience, the students will be equipped to make better adjustments to their life situations in the future. At the sophomore level is the best time to establish self-confidence and lessen anxiety by a group method of study in mental hygiene.

Such an experimental unit on mental hygiene has been tried in our school, incorporated in the study of biology. One of the reasons for including this unit in our curriculum has been mentioned previously. It has been found over a two year period of individual consultations with every student in biology that many problems face our students without our being aware of them. Questions dealing with emotions and emotional tensions were clearly evident in a large number of the students' answers. That high school students had various problems which were not expressed and ill-defined was very evident from talking to them. Emotional problems were revealed when such questions were asked us: "Do you worry over school work?"; "Are you nervous?"; "Do you get angry easily?"; "Do you feel restless?"; and "Do you feel like exploding sometimes?". These questions and others elicited quite a different reaction than a question like: "Do you have any problems?", for this direct and general type of question failed to elicit any response from a student because he was not consciously aware of his many anxieties and emotional tensions. On the other hand, some answers revealed that the students were aware of their specific problems, and others in the group simply did not understand the reasons for their feelings. The more bizarre the student's personality, that is, the more a student failed to conform to the mores of the group, the more difficult it was to get him to admit that he had any problems. In these cases it seemed that the student was definitely trying to "cover up" or protect his self esteem.

During the year two sets of questionnaires were given to the

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[2] Margaret Shields, "We Can Prevent Mental Illness," *Hygeia*, December, 1949, p. 866.

students relating to psychobiological problems of adolescents. These questionnaires were compiled from various psychological and educational sources which were concerned with the ill-defined problems of youth. Through use of these questionnaires and of personal interviews the important problems of the students became apparent and were helpful in determining what the students wanted most to know and the best way to help solve their problems. Around these needs and desires of the students was built an experimental unit on mental hygiene.

The unit on mental hygiene included four major divisions which were:

I. Individual reports
II. Laboratory exercises
III. Understanding yourself
IV. Reproductive physiology

It was felt that within these four divisions most of the materials could be included which would benefit the students. The recurring problems most often confronted were keeping the materials studied in terms of the students' experience, relating materials studied to the students' experience, avoiding theoretical psychology and trying to limit the materials to the problems which were of greatest interest to the students. It is to be supposed that these problems were not completely or absolutely solved, but evidence from the interest shown by the students for these topics gave ample proof that at least the students acquired some information about human behavior.

A pre-test was given (to the students) to determine what they already knew and what things should be stressed in regard to a study of mental health.

Part I: Individual Reports and Background

The first part of the unit was made up principally of individual investigations and oral reports by the group. This part of the unit allowed the student to do some exploratory reading and investigating by himself under the teacher's direction. There was a preliminary discussion of twenty-three topics in order to help the students make a selection based on their needs. Each of these twenty-three topics was written on the blackboard and explained briefly by the teacher, followed by a question period under the teacher's guidance. After reading and exploring various materials, both in and out of the classroom, each student selected five topics, from this list of twenty-three indicating those he would like to study individually in order of his preference. An analysis of the twenty-three topics chosen by the students revealed that seven of the topics were preferred over all others. These seven topics revealed that adolescents were not in-

terested in the things which one would suspect, such as sex; but rather, they were interested in psycho-social problems. The following seven topics were chosen as those preferred:

1. Culture and Personality
2. Behavior of Boys and Girls
3. Parent and Child Relationships
4. Adolescent Psychology
5. Who Is Normal?
6. Age for Marriage
7. Marriage

The students were told to make their first choice, second choice, et cetera, on the basis that, if they could not get their first choice, then perhaps they would be given their second choice, and so on. In this way each one of the students received a topic of real meaning to him and at the same time the teacher could actually manipulate the topics which would be best suited for the individual. Each student's ability was taken into account when he selected a particular topic, especially as to the complexity of the topic. When it was observed that a student had a particular problem, he was given the topic to report on which would help him the most in understanding and correcting his difficulty. The greatest need seemed to be that of studying and clarifying these existing problems. Allowing the students to make their own choices, not only provided a direct approach to the problems presumably most troublesome to them, but, in addition, it also was one of the devices used to create interest in the work.

If one examines the selections rather closely, it is evident that the students were interested in things involved in their immediate experiences such as culture and personality, normality, adolescent psychology, age for marriage and parent-and-child relationships. It is interesting to note that boys and girls at the sophomore level are between two stages of development in so far as social concepts are concerned. On the one hand, they are still quite concerned with themselves and, on the other hand, they are beginning to see that the other person may have some effect on their particular psychological make-up. The process of socialization of adolescents is clearly at work at this age level, affecting most of the class; however, there cannot be a definite line drawn for each individual, inasmuch as this process of socialization takes place within the individual student.

The basic reports were prepared from psychological and psychiatric books in which definite page assignments were given to be read and notes taken. After the student had read the material and was given further help and guidance from the teacher, he had a general idea of the over-all problems in relation to his particular problem. The student was made to feel that he was to be the authority on the

FIG. 1. These pictures show the type of visual materials brought in by the students in their study of mental hygiene.

problem of his choice and the other members of the class would look to him for specific answers in regard to their individual problems in his field of study. In this way it was felt that each student could present a solution to adolescent problems and still cover a relatively large amount of material. Each student was given several questions that he was to answer for the benefit of the class. Every member of the class had a mimeographed booklet containing the name of the report, the questions asked, and space to write the answers. By using this method the inattentiveness of some of the students was eliminated during the time when the reports were being given. The students, after making a basic study of their material, and having an individual consultation with the teacher, were encouraged to gather data from magazines, papers, books, the radio, movies and any other source of material which would help to amplify their reports. Some students were sent to the library during class hour; others in small groups discussed common problems and exchanged ideas, and the teacher stood by ready to direct or help individuals during this period of activity.

At this point several students suggested putting magazine and newspaper articles and pictures on the bulletin board so that all classes could benefit from the items and pool their information. Various headings and placement of the respective materials were discussed and decided by the group. The bulletin board became the meeting place of the students before class started. No one was told to read the bulletin board, but the students themselves enthusiastically approved the materials so that they created in others an interest and a desire to read the materials. Figure 1 shows photographs of the three student bulletin boards.

The topics, studied by the teacher and given to the students, were definitely arranged with two considerations in mind: first, to accomplish gradual development from simple to complex and second, to bring into use additional audiovisual materials which would help to clarify and make less monotonous the giving of reports orally. The first report started with the nervous system and its functions, followed by another report on the relationships of the nervous system to human behavior. In this way, by a gradual approach, the materials could be introduced and assimilated in a logical, progressive manner.

After the first report was given, the matter of public speaking was brought up and discussed by the class. So time was taken to decide on the proper manner in which a person should give a report that would be acceptable to the group.

After each individual's oral report was completed, there were many

problems to be discussed. Some topics elicited more discussion than others, but whether this was due to the very nature of the topic or to the personality of the student giving the report was not definitely known. It was surprising to notice that the students were very much interested and discussed such problems as old age, divorce, and family. By this time the students were somewhat aware of the psychological mechanisms of interpersonal situations at work and, on several occasions, demonstrated their ability to handle individual problems occurring in the classroom by the method of group discussion and analysis with the aid of the teacher's guidance and direction. One such case was that of an individual who exhibited aggressive tendencies. The class, as a group, became aggressive and hostile toward this individual, something that they never had done before. At this particular time the teacher pointed out the group processes at work in this situation, from which a valuable lesson was learned both by the group and the individual. The students became conscious of the fact that each individual has a unique personality pattern and that these individual personality patterns have to be integrated into cooperative group patterns. When the student began to realize that his neighbor had some of the same difficulties that he himself had, then it was realized that insight had been gained. In the classroom discussions of this topic it was not referred to as insight but as "tolerance toward others."

Some of the students wanted to write answers to questions in the same words as the students giving the reports but this was thought to be unwise since each student would gain a better idea of the content of the material studied if he wrote about it in his own words. This point was well taken because the students entered into more discussion than they had heretofore. After reports and discussion periods were ended the teacher summarized the materials which had been discussed.

Another interesting aspect of this experimental unit was that the three classes being used were taught by three different people. There were two student teachers and the supervising teacher. Every Monday morning the plan for the week was outlined and then each teacher taught the material, using his own methods. A pre-test and an evaluation test of this unit were given by the teachers. The results of these tests will be deferred until the latter part of the article.

In between the oral reports other activities were introduced and used such as, discussion of subject matter, bulletin board work, and when appropriate, other audio-visual aids. Especially helpful was a series of five records which were obtained from the United States Government Department of Education. These recordings covered various aspects of mental hygiene, acquainting the students

with common types of mental disorders and how to deal with them, and marriage problems based on a comparison of marriages of the last generation with those of the present generation. The records had the advantage of giving several case histories in story form which the students were keenly interested in analyzing and criticizing.

Another type of audio-visual material used with the reports was motion pictures. There were six movies shown covering the various aspects of mental hygiene. The first three films were concerned with an understanding of the processes involved in mental hygiene. These films dealt with tropisms, insect behavior, instincts, reflex actions, and higher types of human behavior. The last three films were concerned with mental mechanisms. The students enjoyed the films and data on the films were recorded in their booklet on the pages alloted to the pictures. Some additional films will be added next year to help calrify some rather difficult points in mental health.

Another source referred to between reports was the book *Human Relations in the Classroom*.[3] Lessons on good personality traits, making quick decisions, forming a philosophy of life and tolerance were used to demonstrate in a practical way what we were trying to accomplish. These lessons fitted into our program admirably because of their simplicity and their unique method of getting the students to participate, and they also gave the students something practical in the way of analyzing a psychological situation in terms of students' experience. Furthermore, these human relation lessons helped the students to discuss their own difficulties more easily. This was done by presenting a story, then discussing the story, and finally asking the students if they ever had a similar problem. The use of this device was probably one of the most desirable ways to make a transition from an objective situation to a subjective type of situation. Eventually this type of discussion gave the students some insight into their own personality which was one of the main objectives in this unit. This method has proved to be the most effective in getting the students to talk about themselves.

It was felt that the more devices that could be used in teaching this unit the longer and better the students would retain and understand the materials.

Part II: The Laboratory Exercises

The laboratory part of the unit was confined to optical illusions, mazes, trial and error learning, habits and reasoning. The main idea of this division was to have the students understand the basis of learning and the factors involved in the process. Mimeographed mazes

[3] Edmund H. Bullis & Emily E. O'Malley, *Human Relations in the Classroom*, vol. I, Wilmington, Delaware: Delaware State Society for Mental Hygiene, 1947.

were used and the students tried to improve their time of tracing the mazes in successive attempts, thus demonstrating the processes of learning. Various questions relating to learning were asked and answers recorded. Several problems in reasoning were given and the students were timed, then they made up their own problems and tried them on their partners. A lecture on habits was given by the teacher in an attempt to show how important good habits are to effective living.

Part III: Understanding Yourself

In this phase of the unit a booklet[4] was used with a psychiatric approach to personality. The contents deal with teen age personalities and the mental mechanisms used by students to satisfy their emotional needs. The object of using this reference was primarily for organizing, integrating, and correlating the previously learned materials so that retention and practical use of the knowledge would be assured. The immediate retention of the material was good as evidenced by the answers given on the tests. The tests were partially objective and partially subjective; there were matching questions, true false, multiple choice, completion, and essay questions of the problem type. The amount of future retention of this material will depend upon how much insight each student gained during this study and the degree with which he applies this knowledge to his own personality.

As mentioned previously, the students were given two tests: a pre-test, covering various phases of mental hygiene; an evaluation test, covering the same material but given at the end of the unit. Ten questions from the pre-test were compared to ten questions from the evaluation test. The students were asked not to sign their names to assure anonymity. The data in Figures 2 and 3 presents the results of the ten questions taken from the pre-test and the evaluation test.

The significance of these two charts can be determined if one examines question number one on the pre-test and then compares it to question number one on the evaluation test. These questions represent the ten most consequential aspects of the unit. If one examines each question and compares the percentages of the two tests, it can readily be seen that the answers tend to be favorable in terms of the objectives which the author intended the students to attain. It is also significant that faulty knowledge in some cases must have been corrected in the teaching of this unit because some of the undecided students shifted their answers to more favorable answers in the evaluation test.

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[4] William C. Menninger, M.D., *Understanding Yourself*, Science Research Associates, Chicago 4, Illinois, 1948.

A COMPARISON OF TEN QUESTIONS FROM THE PRE-TEST AND TEN QUESTIONS FROM THE EVALUATION TEST

Questions	Yes	%	No	%	Undecided	%
1. Are you happy?	44	73.3	14	23.3	2	3.3
2. Do you like school?	48	80.0	8	13.3	4	6.6
3. Do you have any knowledge in regard to sex?	34	56.6	23	38.3	3	5.0
4. Do you like people?	45	75.0	7	11.6	8	13.3
5. Are you easily upset when people talk about you?	15	25.0	41	68.3	4	6.6
6. Would you like to improve your personality?	42	70.0	6	10.0	12	20.0
7. Do you have personal problems?	29	48.3	22	36.6	9	15.0
8. Do you know what mental hygiene is?	12	20.0	32	53.3	16	26.6
9. Do you feel like exploding sometimes?	30	50.0	25	41.6	5	8.3
10. Do you have different interests?	22	36.6	35	58.3	3	5.0

FIG. 2. Pre-Test.

Questions	Yes	%	No	%	Undecided	%
1. Are you happy?	52	86.6	7	11.6	1	1.6
2. Do you like school?	57	95.0	3	5.0	0	0
3. Do you have any knowledge in regard to sex?	52	86.6	6	10.0	2	3.3
4. Do people like you?	53	88.3	5	8.3	2	3.3
5. When people mention things about you does it concern you?	6	10.0	49	81.6	5	8.3
6. Did you improve your personality?	55	91.6	2	3.3	3	5.0
7. Have you reached some understanding of your problems?	42	70.0	14	23.3	4	6.6
8. Do you have a better concept of mental hygiene?	43	71.6	10	16.6	7	11.6
9. Have you become more tolerant of others?	41	68.3	7	11.6	12	20.0
10. Has mental hygeiene opened new interests for you?	39	65.0	13	21.6	8	13.3

FIG. 3. Evaluation Test.

SUMMARY

Several generalizations and conclusions were derived from the teaching of this experimental unit in mental hygiene.

On the basis of the results, some of which have been presented in Figures 2 and 3, it was clear that a class in biology offered an excellent

opportunity to approach this subject. Moreover, this subject could be taught by the group method which is believed to be more advantageous from the students' viewpoint than individual psychotherapeutic methods.

The approach to an understanding of mental hygiene was through individual study and group discussion with gradually developing insight.

It was felt by the author that students in general were not aware of their many problems but simply treated them as though they did not exist; however, their physical manifestations were observable in many cases which revealed their underlying problems.

As a result of this study and in consideration of the data presented mental development has to be considered on equal terms with physical and emotional development in the individual. These three aspects of the pupil should be integrated within the social situation of the classroom.

This paper does not presuppose that the author has solved the problems of adolescents but rather that he has recognized some of the problems and tried to do something constructive regarding them.

In conclusion it should be said that mental hygiene should be a part of every school program and of each school room situation. Mental hygiene cannot be taught at a certain age level but must be a continuous development throughout the educational life of the child.

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CATTLE DISEASE KILLS 400 ARMY DEER

"Blackleg," a disease which kills thousands of young cattle annually in the United States, has now been found to attack wild deer.

At the Army Proving Grounds at Aberdeen, more than 400 out of about 2,500 deer which roam the reservation have died of the disease. The deaths are reported by Army veterinarians, Lt. Col. H. L. Armstrong and Maj. J. K. MacNames, in the *Journal of the American Veterinary Medical Association*.

Although blackleg can be prevented by vaccination, it is fatal to young cattle which are not immunized, and sometimes attacks sheep and other livestock.

HIGH SCHOOL MATHEMATICS IN COLLEGE ENGINEERING

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Much of the difficulty experienced by college students in engineering is due to their lack of understanding of mathematics. Often the points giving trouble are things studied in, but not retained from, high school algebra. It is quite common to have a student remark that he remembers that some topic was discussed but that he didn't concern himself with it sufficiently at the time because he could see little likelihood of application.

In the hope that they may be useful as supplementary or demonstration problems which will appeal to the future engineers in high school algebra and thus lead to better retention of the processes involved the following engineering problems are submitted.

Problem 1. A machine design test gives the following formulas relating to stresses in a thick tube:

$$S_t = p\left[\frac{D^2+d^2}{D^2-d^2}\right]$$

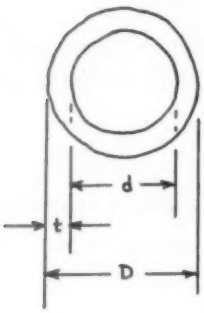

FIG. 1

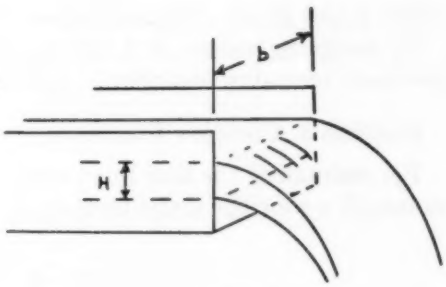

FIG. 2

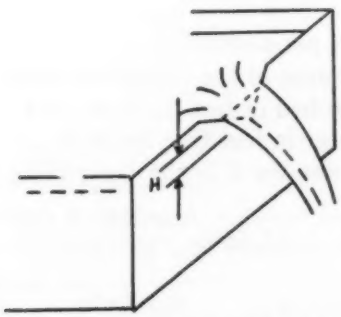

FIG. 3

and

$$t=\frac{d}{2}\left[\frac{\sqrt{S_t+p}}{\sqrt{S_t-p}}-1\right]$$

where

S_t = stress in the tube wall in pounds per square inch,
p = fluid pressure in the tube in pounds per square inch,
t = thickness of the tube walls in inches,
D = external diameter of the tube in inches, and
d = internal diameter of the tube in inches.

Prove that they are equivalent. See Fig. 1.

Problem 2. Fractional Exponents.

Figures 2 and 3 show two common forms of weir, a weir being a notch in a thin wall for the purpose of measuring the flow in streams, irrigation ditches, or other open channels. The flow Q, in cubic feet per second, is given by the formulas

$$Q=3.33bH^{3/2} \text{ (for figure 2)}$$

and

$$Q=2.48H^{2.48} \text{ (for figure 3)}$$

where b and H are distances shown in the figures measured in feet.

By assigning values to b and to either Q or H we have excellent problems requiring logarithmic solution.

Problem 3. Complex Fractions.

For estimating the flow in an open channel when it is not practical to install a weir the usual formula is

$$v=C\sqrt{\frac{AS}{P}}$$

where

v = velocity in feet per second,
A = cross-sectional area of the stream in square feet,
S = slope of stream bed in feet per foot, and
P = wetted perimeter in feet (see figure 4).

A common expression for C is the Ganguillet and Kutter formula

$$C=\frac{41.65+\dfrac{0.00281}{S}+\dfrac{1.811}{n}}{1+\left(41.65+\dfrac{0.00281}{S}\right)n\sqrt{\dfrac{P}{A}}}$$

where n is a roughness factor with a range from about 0.01 to about 0.10.

By assigning values to all but one variable and requesting it we give a purpose to the solution of a complex fraction as involved as any the student is apt to encounter.

Problem 4. A Parabola in Nature. See Fig. 5.

It can be shown (by use of the calculus) that the surface of the liquid in a vertical circular cylinder rotating at a constant speed, N revolutions per minute, about its axis is given by the equation

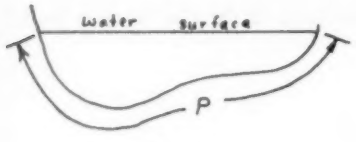

FIG. 4

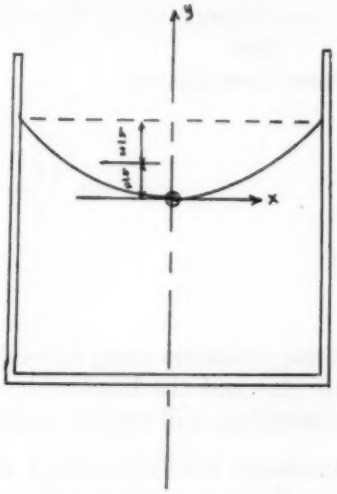

FIG. 5

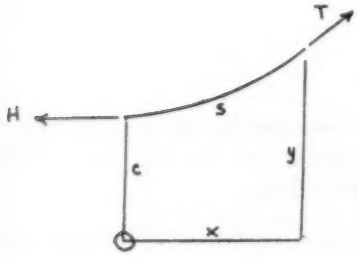

FIG. 6

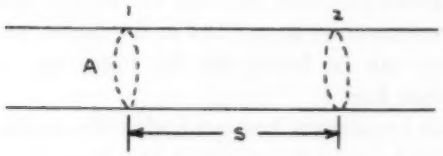

FIG. 7

$$y = \frac{\pi^2 N^2 x^2}{1800g}$$

where x and y are in feet and $g = 32.2$.

It can also be shown (again by calculus) that the water surface when the container is still is half-way between the lowest and highest points when rotating.

Thus we may ask for the maximum speed without spilling knowing, the original level, or for the amount spilled if the center when rotating

drops to h feet, or for the amount spilled if the speed reaches some given value.

Problem 5. The Catenary. See Fig. 6.

A cable loaded at a constant rate of w pounds per foot of cable such as a power line with its own weight plus perhaps an ice load assumes the form of a catenary. Here

H = tension at bottom (horizontal) in pounds,
T = tension at any point in pounds,
c = height to cable above the origin, $c = H/w$ in feet,
x, y = coordinates of a point on the cable in feet, and
s = distance along the cable measured from the lowest point in feet.

Some formulas are

$$y^2 = s^2 + c^2,$$

$$x = c \log_e \frac{s+y}{c} = 0.4343c \log_{10} \frac{s+y}{c},$$

and

$$T = wy.$$

Some problems using these expressions can be made by giving the span $(2x)$ and the length $(2s)$ and asking for the sag $(y-c)$. Other combinations will readily suggest themselves.

Problems involving direct and inverse variation are easily found as are linear equations and graphical representations of all kinds.

Problem 6. A good problem for near the end of the algebra course consolidating simultaneous equations and graphs, and having a true engineering flavor can be based on the following considerations in pipeline design. See Fig. 7.

One of the most important laws of hydraulic engineering is the law of continuity, $Q = Av$, which says that the flow, Q, in cubic feet per second is the product of the area in square feet and the velocity in feet per second. Thus if point 1 in figure 7 represents a "front" of some liquid at time zero and point 2 represents this same front at time t, the volume which has crossed section 1 in t seconds is evidently As cubic feet. But this is As/t cubic feet per second. Since s/t is velocity, v, we have $Q = Av$.

This law taken together with the expression for energy loss due to pipe friction

$$h_f = f \frac{L}{D} \frac{v^2}{2g}$$

h_f = "head" lost in foot-pounds per pound of liquid flowing,
f = a coefficient, nearly constant, depending on pipe roughness. (A good average value of f for cold water is 0.02.)
L = pipe length in feet,
D = pipe diameter in feet,
v = water velocity in feet per second, and
$g = 32.2$
gives rise to some interesting problems in functionality.

a. For the same pipe (L, D, and A fixed) h_f varies as the square of the velocity and thus as the square of Q.

b. For a fixed velocity and length h_f varies inversely as the diameter while Q varies as the square of the diameter (since $A = \pi D^2/4$).

c. For a fixed Q and L, h_f varies inversely as the fifth power of the diameter.

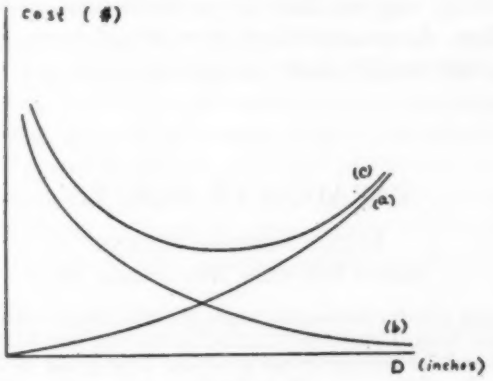

FIG. 8

This follows from

$$h_f = f\frac{L}{D}\frac{\left(\frac{Q}{A}\right)^2}{2g}$$

$$= f\frac{L}{D}\left[\frac{Q}{\frac{\pi}{4}D^2}\right]^2\frac{1}{2g}$$

$$= \frac{8f}{\pi^2 g}\frac{LQ^2}{D^5}.$$

To further emphasize the importance of these relations problems such as the following are useful.

Given the following weights per linear foot for cast iron pipe which may be taken to cost $200 per ton in place and a power cost of one cent per kilowatt-hour, find the total cost of pipe and power required for pumping to overcome friction if it be assumed that the pipe will be used to carry six cubic feet per second for 2,000 24-hour days.

pipe size (in)	weight per foot (lb)
6	35.8
8	52.1
10	70.8
12	91.7
14	116.7
16	143.8
18	175.0

(1 kilowatt = 737 foot-pounds per second. Water weighs 62.4 pounds per cubic foot.)

This study is also useful in work with graphs. The pipe cost gives rise to a graph of form (a) in figure 8, the power cost to one of form (b), and the total cost to one of form (c).

In connection with the graph it is worth pointing out that interpolated sizes do not give a commercial solution. A non-standard pipe would have to be made to order and its cost would much exceed the price per ton quoted for standard pipe.

PARADOX OF FORCES

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A spring balance which reads a maximum of 2000 grams is laid *horizontally face up*, on the lecture table. Cords are attached to the ring end and to the hook end, and to the free ends of the cords are attached 1000 gram weights which hang freely over the edge of the table. To minimize friction it is well to place pulleys at the edges of the table and pass the cords over these pulleys. Cover the scale face with a sheet of paper. Now explain to the class what we have here: 1000 grams pulling *that* way *and* 1000 grams pulling *this* way. What does the balance read? Someone unhesitatingly says 2000 grams! Zero, says somebody! Good. Is there any other opinion? 1000 grams, says some courageous soul! To make the situation democratic a vote may be taken.

The case may now be extended to two such scales in tandem, hook to ring.

IS THE WORLD WARMING UP?

Scientists who make a career of studying the seasons have been quietly debating this point for the past century. Some believe the weather is staying the same; others maintain that the world's temperature has been slowly rising.

A University of Wisconsin professor has gathered evidence from the way wild animals have been behaving that, in some areas at least, the climate has indeed been changing—and for the warmer.

The scientist is Joseph J. Hickey, professor of wildlife management, who recently reported his findings to fellow biologists holding their annual meeting in Columbus, Ohio. He has drawn his evidence from the changing habits of some half dozen species of mammals and birds that inhabit a belt of which the northern limit runs—or ran—between southern Iowa and New Jersey.

THE SCIENCE LECTURE IN THE HIGH SCHOOL ASSEMBLY

IV. THE HUMAN BODY AND THE CHEMICAL CAPERS OF ITS ELEMENTS

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Today I am going to tell you something about yourselves that "not even your best friends will tell you," for the simple reason that they probably don't know it themselves!

I want to tell you of the nineteen chemical elements present in your bodies—some terribly violent when by themselves, others very tame, still others very tame until aroused.

Here I have a specimen of the element oxygen (holds up a jar of oxygen). It makes up the lion's share of your body—65% to be specific. Oxygen is one of the elements which I described as tame until aroused, a fact which I shall demonstrate to you in a moment. As you know, you breathe in order to obtain a supply of oxygen, and it has been said that oxygen is the very bringer of life. To demonstrate, I extinguish the flame of this candle,[1] so (puts jar of carbon dioxide over a burning candle), and now I bring it back to life with oxygen—so—(puts jar of oxygen over the extinguished candle which blazes up again).

To demonstrate that oxygen is tame until aroused—I wet this tablet containing an oxygen compound (potassium chlorate) supported on a block of wood,[2] with a liquid containing phosphorus—so. Now I allow the tablet to dry—(fans the tablet to hasten evaporation). Nothing happens. I arouse the oxygen by pushing it off the table. (Pushes the tablet off the table. It strikes the floor and explodes.)

The second most abundant element in the human body is carbon—making up 18%. (Holds up a specimen.) You see it in fairly pure form when you see coal or charcoal. It is another of the elements which is tame until aroused. One of its compounds, the gas, carbon dioxide, can go up and down stairs like a human being—like this[3] (pours carbon dioxide into a large funnel which has two flights of steps placed in it, each step having a candle fastened on it—all candles are lighted just before pouring the carbon dioxide).

[1] If a wooden splint is split down its length and one half is then forced into the candle, near the wick, a spark will remain when the flame is extinguished and will facilitate relighting by oxygen.

[2] The carbon disulphide is saturated with yellow phosphorus. Any unused solution should be destroyed immediately after the lecture as it is a fire hazard. If the tablet of potassium chlorate does not explode when it lands on the floor, drop a weight upon it.

[3] The two flights of stairs make the same angle with each other as the sides of the funnel, so that the contrivance is supported by the sides of the funnel.

The next element in order of abundance in the body is hydrogen and it is present to the extent of ten percent. (Shows a specimen.) It is not so tame, as you will note when I apply a flame to a mixture of hydrogen and air. (Applies flame—explosion results.)

Next in quantity is nitrogen—but it makes up only 3%. (Shows a specimen.) Some of its compounds, for example T.N.T.—trinitrotoluine—are very excitable, but when nitrogen is by itself it is very tame. I have only time to demonstrate why it is called "choker" in some foreign languages—(puts burning candle into a jar of nitrogen—flame is extinguished).

The first three elements, namely oxygen, carbon, and hydrogen form compounds with each other. You have some of these compounds in your body as carbohydrates (sugars and starches) and fats. When oxygen, carbon, and hydrogen enter into combination with nitrogen, the very important compounds known as proteins result, and you have these in your body also, as muscles, nerves, skin, hair, etc. The foods which furnish this element to the body are lean meat, eggs, cheese, milk, poultry, etc.

Calcium, amounting to 2%, is next. Not far below it in the list of metals in the human body are potassium 0.35% and sodium 0.15%. These last two are strangely behaving metals—they are so soft that they can be cut with a knife. (Cuts potassium and sodium and covers them with coal oil in a beaker.) All three of these metals are violent in their reactions with water, and with oxygen, but calcium is least active so that it may be exposed to air. The other two must be protected against air and moisture, therefore I have poured coal-oil over them. Let us see how they behave toward water. First calcium—(drops a piece of calcium into a tall cylinder of water). The effervescence you see is due to hydrogen. It is released from the water. At the same time calcium hydroxide is formed. This is a kind of chemical called a base. Note what happens when I add phenolphthalein—(does so—red color appears). Now I add some hydrochloric acid—(color disappears).

Sodium is even more violent. I place my piece of sodium upon a piece of paper floating upon water, then cover[4] it, in case the reaction becomes too violent. (Pauses—.) Here we see a fire upon water.

Even more violent is potassium—for it will act upon water cold enough to be ice. I place my piece of potassium upon a piece of ice and await developments! (Covers ice and potassium in same kind of apparatus as is used for sodium demonstration—potassium catches fire.)

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[4] Large crystallizing dishes are well suited for the demonstrations with sodium and potassium. The dishes should be covered with sheets of glass as soon as the sodium and potassium have been introduced, to prevent products of the reaction from being hurled into the air.

A fully grown human body contains about three pounds of calcium, mostly present in bones, where it is combined with phosphorus and oxygen in a compound called calcium phosphate. The body also needs a supply of calcium for producing a clot when bleeding starts. The best foods for obtaining calcium are milk, cheese, leafy vegetables, cereals, peas and beans. In America more people are apt to lack calcium than any other element. Bad teeth and rickets are among the diseases which might result from calcium insufficiency.

Potassium is found in fruits and vegetables, especially potatoes. Sodium enters the diet mostly as table salt, needed for one of the ingredients of the gastric juice of your stomach. Heat prostration is due to loss of salt from the body.

While we are speaking of violent elements like the last three examples, let us try something with another "frisky" one—phosphorus. Notice that this one is so unfriendly that it must be kept under *water*, not coal oil! (Holds up a specimen so audience can see it.) Here I have a solution of phosphorus in carbon disulphide. I carefully spread some of this solution upon a piece of paper, then holding the paper with forceps I wave it through the air so as to allow the carbon disulphide to evaporate. (Pauses until paper catches fire.) This element makes up 1.1% of your body, so if you ever "set the world on fire," or "start a flame in someone's soul" you can blame it on your phosphorus. Your bones, teeth, blood, nerves and muscles need it. It is present in cheese, nuts, eggs, meat, and milk. Matches contain phosphorus—a half million could be made from your skeleton, which contains about two pounds.

Lest you start wondering why you can get into your bath without decomposing the water, as did the calcium, or how it is that the air doesn't set fire to you as was the case with phosphorus, remember that these elements behave that way only when by themselves. In your body they are not present by themselves, but as compounds (combinations) with other elements.

Now we come to sulphur—0.25%. It is tame until aroused. I light some sulphur in this deflagrating spoon and lower it into a jar of oxygen—this beautiful spectacle results. The body needs sulphur for muscles, skin pigment and so forth, and obtains it from onions, radishes, cabbage, meat and poultry and other foods. Hair and nails became brittle due to a lack of sulphur. Red hair has the highest sulphur content.

Let us see how magnesium, a metal used in airplanes, and present in the human body to the extent of 0.05% behaves in oxygen (burns magnesium in oxygen). This element is needed by the bones, blood and muscles, and is obtained from the fruits and vegetables you eat.

Chlorine, of which I have a specimen (holds up bottle) is a greenish

yellow, poisonous gas, used to kill in the first World War. You obtain your supply from the salt you eat. The body contains only 0.15%, which is used for making the hydrochloric acid of the gastric juice. I dip a piece of paper into warm turpentine and thrust it into this jar of chlorine gas (black smoke and a red flash result). Another interesting way to demonstrate the activity of chlorine is to mix this colorless solution of potassium iodide and starch with a few drops of a solution of chlorine in water. Chlorine is so active that it pushes the iodine out of the potassium iodide, thus setting it free. The free iodine can now unite with the starch, producing this beautiful blue color. Iodine is also needed by the body, which contains 0.00004%. Fish, chiefly haddock and cod, lemons, eggs, milk, butter, radishes, etc., as well as river water, furnish us with this element. When it is missing in proper quantity from the diet the disease called "goitre" results.

I regret that I have no time left to demonstrate the properties of the element fluorine (needed by the teeth) or iron and copper (needed by the red corpuscles). These are very important, although they are present in very small amounts.

The question as to how we obtain the nineteen elements of the body has already been answered. We don't eat them in lumps of minerals—we obtain them from a properly selected diet. The poet Goethe says, "Mann ist was er iszt,"—that is "we are what we eat." So don't forget the green, yellow and red vegetables, the orange juice, water, meat, milk, fruits and all the other needed foods, and lots of fresh air, if you want the rosy cheeks and the health and strength of the athlete.

HIGH HILL NEAR RIO DE JANEIRO SITE OF CITY'S FIRST TELEVISION

Sugar Loaf mountain close to this city is the site of a commercial television broadcasting station now nearing completion. The 150-foot antenna on the top of 1,300-foot Sugar Loaf will provide an extended reception area.

This TV transmitter is being erected by the International General Electric Company and will be ready for use in the near future. The equipment was constructed by General Electric's electronic department at Syracuse, N. Y. Programs of the Rio station will include studio shows and remote broadcasts from the city's race track and athletic fields.

Erection of the station on the summit of Sugar Loaf presented many difficulties because the site can not be reached by automobile. A cable car to the top for tourists brought some of the equipment. Much was carried to the top by mules.

· Floor finish for gymnasiums, handball courts and other recreational rooms is a plastic product utilizing cellulose. Several coats are applied, the first of which penetrates the wood to make a perfect bond. The finish is transparent and does not change the color of the floor.

A STATISTICAL ANALYSIS OF SOME FACTORS INVOLVED IN THE PREPARATION OF HIGH SCHOOL GENERAL SCIENCE TEACHERS

EGON G. GUBA AND KENNETH E. ANDERSON
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THE PROBLEM

The typical graduate of a teacher training institution who intends to teach science on the secondary school level has accumulated the majority of his science credits in one area, or at least in a limited number of areas. Yet general science as a subject has become so widely accepted in the secondary schools of the nation that it would be a rare science teacher indeed who at one time or another were not called upon to teach this subject. And if, as is often true, the general science course as offered is an attempt to present pertinent information drawn from a variety of fields, it would seem to indicate that the average teacher will have had little or no training in some of the areas which he will be expected to teach.

The problem of this study was twofold:

A. A description of the typical graduating senior with a teaching major in science. Information was sought on sex, age, teaching experience, grade point average, units of high school science, credit hours of college science, both total and by specialized areas, and the teaching major.

B. It has been assumed that there may be several factors operating in the education of the typical science major that serve to "generalize" his knowledge sufficiently to make of him an adequate general science teacher. Comparisons aimed at a determination of the contribution of each of the following factors were made:
   1. The grade point average of the student in science subjects.
   2. The age of the student.
   3. The sex of the student.
   4. The type of school in which the student has received training, whether state university, private college, or teachers college.
   5. The number of units of high school science earned by the student.
   6. The number of semester hours of college credit earned by the student.
   7. The science areas in which the student has accumulated most of the semester hours with which he is credited.
   8. The broadness of the student's training in science.

To determine the student's knowledge in the area of general science, the *Cooperative Test of Proficiency in Natural Science, Form S*, was administered. The test consists of two parts, Part I, "Terms and Concepts," and Part II, "Comprehension and Interpretation." Each of the factors listed under (B) above was studied in the light of the test scores, the study being made separately for each part of the test.

THE SAMPLE

The sample consisted of 233 students, purportedly graduating

seniors from a teacher training institution, with a teaching major in one of the science areas. Science minors were not included. Subsequent checks revealed that some members of the sample were not science majors, or that in several cases the information requested on the questionnaire was not usable. Elimination of these cases cut the sample to 208 individuals. They were drawn from five state universities, five private colleges, and four teachers colleges, distributed geographically as follows: three schools from Minnesota, two from New York, and one each from Kansas, Massachusetts, Indiana, Colorado, Nebraska, Iowa, Ohio, Wisconsin, and New Jersey.

No claim is made for the randomness of the sample. Schools were selected largely on the basis of available contact, and only schools that the author considered might cooperate freely were invited. Cooperation was, of course, entirely voluntary.

The Questionnaire

A questionnaire was necessary to ascertain data on the basis of which the actual comparisons were to be made. Information was elicited in the areas defined in (A) and (B) above, which constituted the basic factors to be evaluated. In an attempt to assure honesty in response, students were asked not to place their names in evidence anywhere on the questionnaire nor on the test blank, so that they might be assured of the complete anonymity of their responses. The questionnaire and the test were both completed under the supervision of a faculty member of each of the cooperating schools.

The Statistical Analysis

To secure descriptive information for Part A of the study, the mean, median, Q_3 (75th percentile), Q_1 (25th percentile), and standard deviation were calculated for the distributions for each of the characteristics listed in (A) above. The comparisons in (B) were made through the use of the technique of analysis of variance-covariance, wherever possible. When the basic assumption of homogeneity of variance was not met, the Behrens-Fisher "d" test was used. Where the test for homogeneity of regression failed, the "t" test was used. In both these instances comparisons were made for all possible combinations of groups taken two at a time. The factors of age and grade point average were tested by setting up multiple regression equations, and testing the statistical significance of the standard partial regression coefficients for each of the factors, and for each part of the test.

The Findings

The data of the descriptive portions of the study capable of sum-

mary are shown in Table I. For the sex factor, there were 155 males and 53 females in the sample. Only 15 of the 208 cases had had any teaching experience, so that this factor was excluded from consideration. The mean grade point average for the entire sample was 1.795, with a standard deviation of 0.466 ($A = 3$). A complete distribution of grade point average was not determined.

TABLE I. SUMMARY STATISTICS FOR EACH OF THE CHARACTERISTICS OF PART A OF THE STUDY

Characteristic Summarized	Units	Mean	Median	Q_3	Q_1	Sigma
Age	Years	24.02	23.75	25.83	21.97	3.71
Units of HS Science	Units	3.79	3.85	4.53	3.12	1.19
Total Hours of College Credit in Science	Sem. Hours	50.93	51.17	58.87	39.58	15.07
Hours in Biology	Sem. Hours	20.67	20.15	28.71	12.00	13.59
Hours in Chemistry	Sem. Hours	17.53	15.38	24.55	8.34	12.06
Hours in Physics	Sem. Hours	9.55	8.21	12.25	5.65	7.74
Hours in Earth Science	Sem. Hours	3.85*	1.78*	4.39*	0.73*	6.78*

* These statistics are somewhat misleading. They were calculated from a distribution for which the lowest interval, 0–2, contained 137 cases. The vast majority of these had zero hours, so that the median individual actually had zero hours of earth science credit.

Considerable confusion arose in the assignment of students to major areas, since there is considerable variation in the descriptive names attached to each type of major from school to school. When students were arbitrarily assigned to a major area on the basis of having the most hours in that area, the majority of students were "majors" in biology, followed by chemistry, physics, and earth science in that order.

The data for the determination of the statistical significance of the factors of age and grade point average on each part of the test are summarized in Table II. The factor of grade point average is seen to be significant for both parts of the test, while age is significant for Part II only.

TABLE II. DATA TABLE FOR THE DETERMINATION OF MULTIPLE CORRELATION COEFFICIENTS, STANDARD PARTIAL REGRESSION COEFFICIENTS (B), AND THE SIGNIFICANCE OF B FOR PART I AND PART II OF THE COOPERATIVE TEST WITH AGE AND GRADE POINT AVERAGE

	$r_{1,3}$*	$r_{1,2}$†	$r_{2,3}$‡	B_1	B_2	$R_{1,23}$	SE_B	B_1/SE_B	B_2/SE_B
Part I	.0053	.1811	−.0107	.0072	.1812	.1813	.0685	0.105	2.631‖
Part II	−.1517	.1563	−.0107	−.1501	.1547	.2167	.0680	2.210§	2.270§

* Zero-order correlation between the part of the test and age.
† Zero-order correlation between the part of the test and grade point average.
‡ Zero-order correlation between age and grade point average.
§ Significant at the 5 per cent level.
‖ Significant at the 1 per cent level.

Data showing the results of comparisons for each of the additional factors for Part B of the study are summarized in Tables III, IV, and V. Sex is seen to be statistically significant for both parts of the test, and total hours in science for Part I of the test. All other factors proved to be statistically non-significant for both parts of the test.

TABLE III. FACTORS CONTRIBUTING TO SUCCESS ON PART I AND PART II OF THE COOPERATIVE TEST OF NATURAL SCIENCE DETERMINED THROUGH THE VARIANCE-COVARIANCE TECHNIQUE

Comparison	*df*	*F*	Adjusted means if *F* was significant
Males vs. Females, Part I	1–204	3.894*	Male: 44.728 Female: 43.348
Males vs. Females, Part II	1–204	7.167†	Male: 26.091 Female: 23.853
Types of Schools, Part II	2–203	0.089	
High School Units, Part I	1–55	2.032	
High School Units, Part II	1–55	1.500	
Total Hours in Science, Part I	1–100	6.227*	upper ½: 45.282 lower ½: 42.835
Hours by Individual Areas, Part II	2–187	2.466	
Broad vs. Narrow, Part II	1–60	1.522	

* Significant at the 5 percent level
† Significant at the 1 percent level

TABLE IV. FACTORS CONTRIBUTING TO SUCCESS ON PART I AND PART II OF THE COOPERATIVE TEST OF NATURAL SCIENCE DETERMINED THROUGH THE BEHRENS-FISHER "*d*" TEST

Comparison	*d*	n_1	n_2	$\sqrt{\text{Ratio of Variances of Means}}$	Significance
Private colleges vs. State universities, Part I	1.938	43	44	.907	not signif.
Private coll. vs. Teachers colleges, Part I	0.763	43	43	.631	not signif.
State universities vs. Teachers colleges, Part I	2.980	43	44	.327	not signif.
Total Hours in Science, Part II	0.149	52	52	1.106	not signif.

TABLE V. FACTORS CONTRIBUTING TO SUCCESS ON PART I AND PART II OF THE COOPERATIVE TEST OF NATURAL SCIENCE DETERMINED THROUGH THE USE OF THE "*t*" TEST

Comparison	*t*	Significance
Most hours in biology vs. most hours in chemistry, Part I	0.692	not signif.
Most hours in biology vs. most hours in physics, Part I	0.572	not signif.
Most hours in chemistry vs. most hours in physics, Part I	0.729	not signif.
Broad vs. narrow, Part I	1.913	not signif.

CONCLUSIONS

The test as a whole proved to be rather easy for the majority of cases, and this fact places some doubt upon the value of the results of the analysis. The validity of the test used with the particular population of this study is rather questionable, and the fact that so few of the factors tested were found to have any relation to the test scores may well have its basis here. If the test had been more highly discriminating, more of the factors might have been found to have a bearing.

However, one can conclude that on the average and within the limitations imposed on the findings:

I. Students were more successful in generalizing their knowledge of scientific terms and concepts as measured by Part I of the test when they were: (1) males, (2) in the upper one-fourth of the distribution in terms of total number of semester hours of college science earned, and (3) better than average students as evidenced by grade point averages.

II. Students were no more successful in generalizing their knowledge of scientific terms and concepts as measured by Part I of the test when they were: (1) older rather than younger in age, (2) credited with several units of high school science rather than few, (3) students at different types of institutions: university, private college, or teachers college, (4) classified as a specific science major, chemistry, physics, or biology, and (5) broadly rather than narrowly trained in the sciences.

III. Students were more successful in interpreting and comprehending scientific material as measured by Part II of the test when they were: (1) males, (2) younger rather than older in age, and (3)

better than average students as evidenced by grade point averages.

IV. Students were no more successful in interpreting and comprehending scientific material as measured by Part II of the test when they were: (1) credited with several units of high school science rather than few, (2) students at different types of institutions: university, private college, or teachers college, (3) classified as a specific science major: chemistry, physics, or biology, (4) broadly rather than narrowly trained in the sciences, and (5) in the upper one-fourth of the distribution in total number of semester hours of college science earned rather than in the lower one-fourth.

A rather high degree of confidence may be placed in the findings of the descriptive portions of this study. While the representativeness of the group was not established, the sampling was rather large and widely distributed geographically. The data from which descriptive characteristics were calculated were all taken from the student questionnaire, in no way related to test responses. To the extent to which the sampling was typical, the group was typical of the general situation in the United States.

Thus we may say that the typical science student in this study was (1) a male with a median age of about 24 years and without teaching experience, (2) a student with a C+ or B− average in science courses taken, (3) a student possessing almost 4 years of high school science credit, and (4) a student possessing a median number of hours of 51 in all science, 20 in biology, 15 in chemistry, 8 in physics, and zero in earth science.

NEW CHAIRMAN OF GEOLOGY

Prof. Stanley A. Tyler has been elected new chairman of the University of Wisconsin geology department, the University announced today.

He succeeds Prof. R. C. Emmons, department chairman from 1945 to 1950.

Professor Tyler is a native of Wisconsin and holds three degrees from the University. He received the Ph.D. in 1935 and joined the Wisconsin geology faculty the same year. He also has taught at North Dakota Agricultural college.

He has been consulting geologist for Jones and Laughlin Iron and Steel Co. since 1937, and is a fellow of the Geological Society of America.

ERRATA

In the October issue under "Books Received" errors were made in the listing of the book given below.

THE EARLY DEVELOPMENT OF THE CONCEPTS OF TEMPERATURE AND HEAT. THE RISE AND DECLINE OF THE CALORIC THEORY, prepared by Duane Roller, *Wabash College, Crawfordsville, Indiana.* Paper. Pages iv+106. 15.5×22.5 cm. 1950. Harvard University Press, Cambridge 38, Mass. Price $1.25.

A DIAL-A-FACTOR

ETHEL L. GROVE, CHARLES E. SCOTT, AND EWART L. GROVE
Cleveland, Ohio

I. Construction

A. Materials

1. One 3″×5″ correspondence card or stiff cardboard.
2. Four circular cardboard disks 2″ in diameter.
3. Four paper fasteners.
4. Black, blue, and red ink.

B. Steps in construction

1. In 3×5 card cut out rectangles 1, 2, 3, and 4 as shown in Figure 1. Rectangles are $\frac{1}{4}$″×1/8″.
2. Inclose rectangles 1 and 2 with a ± sign between them in one parenthesis and rectangles 3 and 4 with a ± sign between in another parenthesis. (Use black ink for this.)

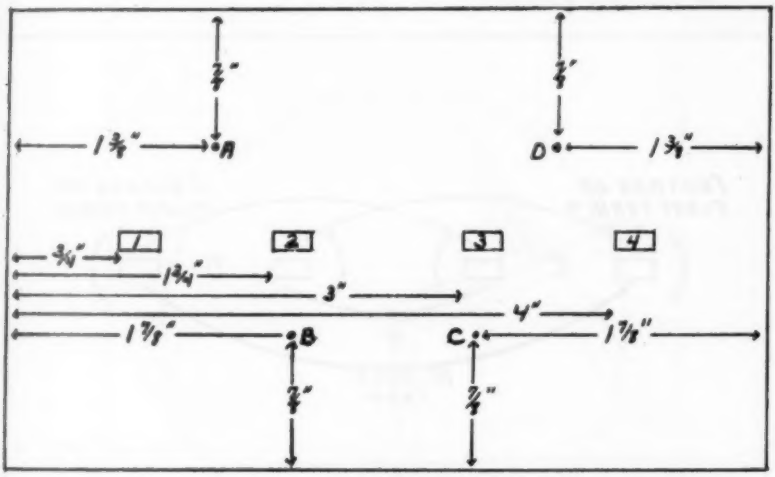


FIG. 1. Dial-a-Factor

3. With black ink draw arc joining rectangles 2 and 3 and another joining rectangles 1 and 4, place a + sign between these two arcs, and label this "MIDDLE TERM."
4. Locate points A, B, C, and D as shown in Figure 1.
5. Divide each of the four disks into 20 equal sectors.
6. Number sectors on dials 1 and 3 from 1 to 20 clockwise with blue ink. Number dials 2 and 4 counterclockwise with red ink. (To find exact location and slant of numbers on each dial, attach dial temporarily back of corresponding rectangle by a pin through its center and corresponding point on card. Hold pencil point in opposite corners of rectangle and rotate dial to mark off visible area on disk.)

7. Attach completed dial 2 to back of card at B with paper fastener through its center, dial 1 at A, dial 3 at C, and dial 4 at D.
8. With blue ink draw arc joining rectangles 1 and 3 and label "FACTORS OF FIRST TERM."
9. With red ink draw arc joining rectangles 2 and 4 and label "FACTORS OF LAST TERM."

II. Use

A. For pupil use

This DIAL-A-FACTOR may be used to make fun of the usual drudgery of trial and error in finding factors of more difficult trinomials. This individual-sized card is an "interest" device and not strictly a teaching aid. The rules for factoring trinomials and choosing signs must be understood before using it. (Each pupil may make his own DIAL-A-FACTOR in club or activity period.)

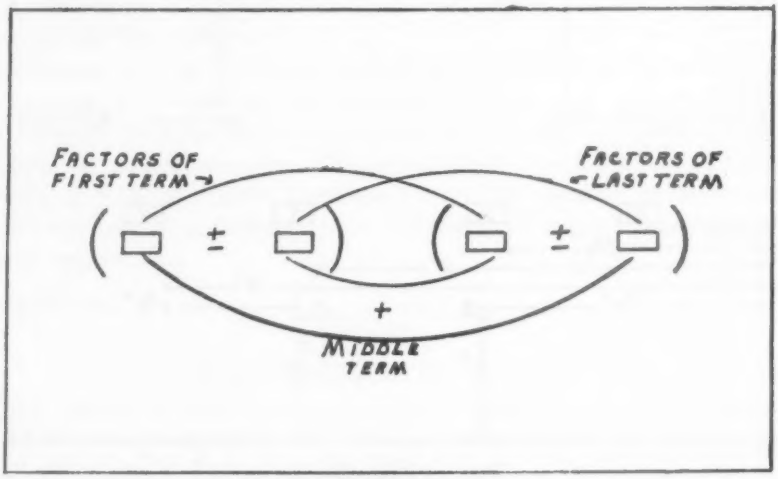


FIG. 2. Dial-a-Factor

1. By turning dials 1 and 3 put a probable pair of factors of first term of trinomial in spaces 1 and 3. (Blue terms.)
2. By turning dials 2 and 4 put probable factors of last term in spaces 2 and 4. (Red terms.)
3. Check sum of products of middle terms and end terms of factors with middle term of trinomial. (Black term.)
4. If these factors do not check other combinations can be tried by rotating dials.

B. For teacher demonstration

An enlarged model of this device may be used in demonstrating rules for factoring to fix pattern in pupils' minds.

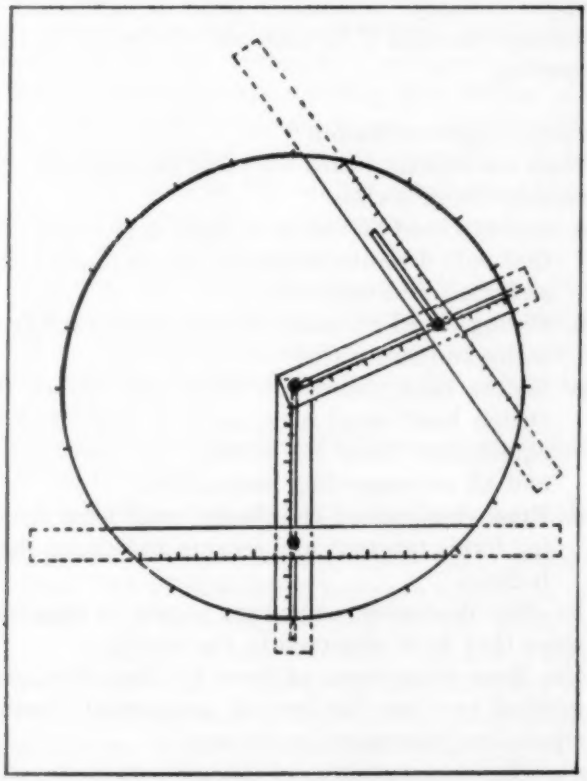
MODEL FOR CIRCLES AND STRAIGHT LINES

ETHEL L. GROVE
1814 Tuxedo Avenue, Parma 29, Ohio

I. Construction

A. Materials

1. Two cardboard rectangles approximately 15″ × 20″.
2. Two cardboard strips 3/4″ wide and 14″ long (chords).
3. Two cardboard strips 1″ wide and 7″ long (radii).
4. Three paper fasteners.
5. Glue and Scotch tape.
6. Pen and ink.



CIRCLE AND STRAIGHT LINES

B. Steps in construction

1. Draw a circle 12″ in diameter in center of one rectangle.
2. Divide circle into any convenient number of small equal arcs and ink these division points on outside of circle.

3. Cut out circle and glue remainder of rectangle onto the other rectangle. Do not glue more than $\frac{1}{2}''$ from edge on any side. (Bind edges together with tape if necessary.)
4. Starting $\frac{1}{2}''$ from end of radius, cut a lengthwise slot $1/8''$ wide and $6\frac{1}{4}''$ long through center of each radius.
5. From point $0'$ $\frac{1}{4}''$ from same end of radius mark inches, half inches, and quarter inches outward along edge of slot.
6. Mark inches, halves, and quarters on outer edge of chords.
7. Attach a chord to each radius by paper fastener through center of chord and slot in radius. (If cardboard is stiff a short $1/8''$ slot may be cut in central portion of either or both chords also to permit more general illustrations.)
8. Slip ends of chords and radii under circular opening in upper rectangle and fasten radii to backboard by paper fastener through $0'$ in each and the center of the circular opening.

II. Use

A. For pupil experimentation

1. Place on bulletin board for pupil investigation before discussing circles in class
   a. Sliding chord on radius at right angles and tilted shows that only a radius perpendicular to chord bisects chord and arcs, and converses.
   b. Sliding chord on radius shows corresponding change in major and minor arcs.
   c. Sliding both chords on their radii shows that equal chords have equal arcs, equal central angles, and are equidistant from the center; all converses of these; and all corresponding inequalities.
   d. Removing ends of chords and radii from circular opening forms tangents and secants and shows their characteristics.
2. In class discussion encourage pupils to suggest relationships they have observed in the model.
3. Use these suggestions as basis for class discussion and as original exercises for outside assignments instead of the equivalent statements in the text.

B. For teacher demonstration of theorems on circles and straight lines.

C. For flash-card review of terms and principles related to circles.

D. Model can also be used with unit on arc and angle measurement by making chords and secants intersect inside, on, and outside circle.

PUTTING MORE MEANING IN THE TEACHING OF MEASUREMENT

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Measurement—direct and indirect—is probably the most important concept taught in junior high school mathematics. It assumes this position because of its interesting history, its social usage, and the mathematical operations involved in its use and computation. Nearly all junior high school textbooks contain some chapters, or sections, devoted to the subject of measurement.

Though the value of training in measurement seems to be generally agreed upon by teachers and textbook writers, methods of presenting this training differ from textbook to textbook. One of the basic principles underlying the modern teaching of secondary mathematics is that of providing experiences which have social significance and interest for the participating youngsters. Keeping this principle in mind, the best authorities on the subject recommend that problems and exercises in arithmetic and measurement be made as meaningful as possible. Yet some of these same authorities, when they write textbooks for junior high school use, apparently forget the principle which they are so ready to reiterate. Several cases of this point may be illustrated by reference to a series of exercises which have been selected from recently published textbooks for junior high school mathematics classes.

In dealing with direct measurement of time, one textbook surveyed has the following problem:

(1) When it is midnight at Peking (120 E.), what time is it at New York?

Though it is important for seventh and eighth grade pupils to be able to calculate time, and to understand concepts relating to world time zones, the problem as stated has several defects which cripple its effectiveness for training the age group for which it is intended.

The problem is not entirely real to the pupils—many of them do not know, or care, where Peking is located. The problem presupposes that the pupils know: (a) what time belt New York is in, or the longitude of New York; (b) that they know that (120 E.) means 120 degrees east longitude; (c) that time gets earlier as one travels *westward* from the starting point; (d) that 15 degrees of longitude equals one hour's difference in time. The problem also has a trick in it which might upset the pupils' calculations because one must also consider the location, function, and meaning of the International Date Line. Giving the longitude of Peking as an even 120 degrees East is hardly

accurate from a geographic standpoint, while reference to a map for the location of New York City would not give a similar even longitude reading. Such suppositions of previous knowledge invalidate the use of such a problem unless one is certain that such knowledge and understanding exist.

To develop the same concept of time calculation, I would suggest the following problem:

> As one travels eastward along the earth's surface, time becomes later; if one goes westward, time becomes earlier. For example, if it is 3 o'clock p.m. in New York, it is about 8 p.m. in England, and about noon in California, as England and California are respectively east and west of New York. The time changes one hour for each 15 degrees difference in longitude.
>
> Consult a map or atlas for the longitude of Denver, Colorado, recording it to 0.5 of a degree. If New York is at West Longitude 74, what time is it in Denver, when it is noon in New York? Check your calculations with your airways world time chart. Explain any differences.

The substitute problem gives necessary information, gives the pupils the opportunity to look up certain data, requires them to record this information to 3-figure accuracy, and then enables them to check their computations against a standard. In working the problem, they would get practice in locating information, taking measurement (location) from a map, manipulating a scale (time chart), multiplying and dividing fractions, and rounding off the answer. The problem also has more interest and significance because it involves American cities and time zone differences of which they are already aware.

A second problem from the same textbook occurs as an exercise under direct measurement. It is:

> When a man 6 feet tall casts a shadow 10 feet long, how tall is a tree whose shadow is 120 feet long?

The author intends for the pupils to solve the problem by the method of similar triangles. Looking at this exercise, one can see that all measurements are given—in even numbers. This is not quite realistic as few men are *exactly* six feet tall and few shadows *exactly* an even number of feet long. The problem becomes merely a notebook exercise, with little practical value. The idea might be improved in the following way:

> Select one of your classmates and measure his height very carefully to the nearest inch. Take him outside in the sunlight and measure the length of his shadow. At the same time measure the length of the shadow cast by a tree, pole, or building. From these measurements, calculate the height of the tree, pole, or building by the method of similar triangles.

In the revised problem, pupils will have to supply their own measurements, expressing them to the nearest inch, securing 2-figure accuracy. Their computations would be a *real* problem since they are measuring

things. They may check their results by using several different pupils as subjects for the height and shadow measurements. In taking these measurements they also learn techniques of using tapes, running lines over uneven terrain, and measuring an odd-shaped object like a child.

An even more recent textbook which purports to present mathematical material of great social significance, in a section on indirect measurement, has the following problem:

> With a transit 180 feet from the base of a school building, the angle of elevation of the top was found to be 32 degrees. Find by a scale drawing the height of the building.

This exercise is still unrealistic—all measurements are given, and in even figures involving no fractions. All pupils have to do is select a suitable scale and draw the figure. They get practice only in drawing. There is no way to check the accuracy of the data or results. It is still a paper transaction. Would it not be better to say:

> Take a transit outside and mark a base line on the ground running 200 feet perpendicularly from the school wall. At the end of the line, set the transit and find the angle of elevation of the school roof. From a point on the same base line 100 feet from the wall, find the angle of elevation. Calculate the height of the building by two scale drawings. Compare your results and explain any differences in them.

In the second case, the problem is real. Pupils take their own measurements—running lines, operating the transit, reading and recording data. They have some way of checking their results. The problem ceases to be a mere paper exercise.

Nearly every textbook has a "boy scout" problem involving either direct or indirect measurement. These are usually word pictures, and diagrams, of a boy scout group finding the distance across a river or mapping a campsite. A typical problem of this kind is:

> George and Henry, while on a scouting trip, wished to find the distance across a river. After taking a few measurements, they made a drawing of their problem (Fig. 1). Using a protractor for angles and letting 1 inch equal 15 feet, make a scale drawing and find the distance across the river.

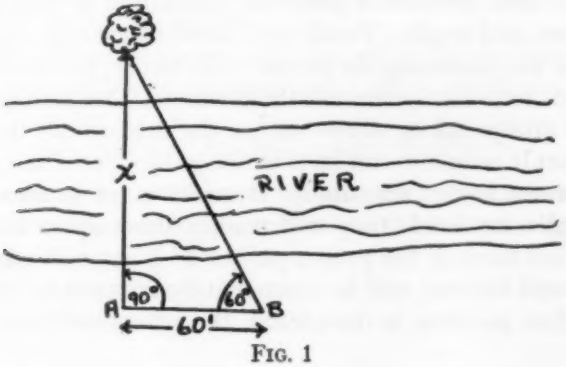

FIG. 1

This problem is artificial and the task asked for is a simple drawing exercise without much meaning. The fact that George and Henry were scouts does not make it any more meaningful. In truth, distance x is not the distance across the river, for the distance from point A to the water's edge, and that from the tree to the water's edge are not given. When the problem is solved, an erroneous conception of *distance* across the river will ensue.

I would suggest more meaningful exercises in place of some of these "boy scout" problems. One such problem, of practical and permanent value might be expressed as a class project:

We are going to lay out a softball diamond for our playground (Fig. 2). To do this, we must construct a square 45′ 0″ on a side. The pitcher's box is $32\frac{1}{2}$ feet from home plate on the straight line running through second base and home. Following the diagram and using the proper tools, let's proceed with the project.

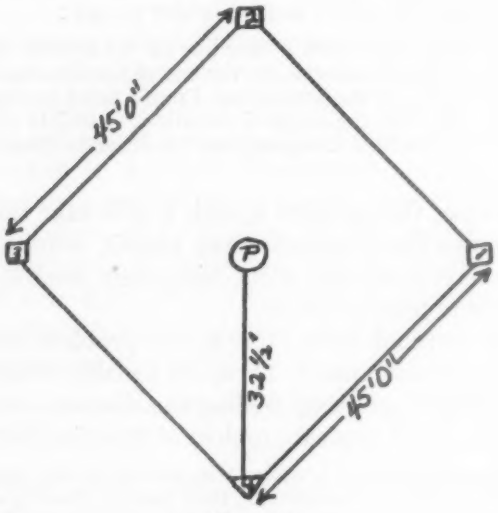

FIG. 2

This project then becomes a practical problem in accurate measurement of lines and angles. Pupils will have to exercise judgment in choosing the site, selecting the proper tools to use, and in figuring the best methods to use in laying out the diamond. The task may use the entire class group, taking them out on the field where they will experience what it means to run lines on the ground, and how important it is to measure angles accurately. If errors occur in measuring the lines or angles involved, they will readily show up as the line segments will not meet at the proper points. It is not necessary to mention that pupil interest will be immediately aroused by the project. After the class problem is completed, the school will have acquired

a new softball diamond, and the class will have experienced deeper insights into some basic concepts of measurement.

The point of the previous discussion has been to show that despite claims to the contrary, new textbooks in junior high school mathematics still contain, in too large a measure, exercises which are un-real impractical, and which do not encourage pupils to locate data, to plan methods of solution, to check results, or to evaluate errors. Though these textbook problems are taken from aviation, modern science, or social organization, they still remain mere paper exercises.

Therefore, if the teacher wishes to make problems in measurement more meaningful to pupils, it behooves him to change these textbook exercises, or invent new ones to replace them. The few examples mentioned here are samples of the latter choice.

THE RULE FOR SEVEN

HOLLIS D. HATCH
English High School, Boston. Mass.

In my physics class we often end a problem with an equation like:

$$28x + 175(26) = 70(40)$$

The value of x can of course be found without simplifying but dividing by a common factor usually makes the solution easier. So I take the time to show how you may by inspection or a simple test find whether a number is an integral product of 2, 3, 4, 5, 6, 8, 9, 10, or 11. The gap for 7 has always intrigued me and recently I have found a test for it also.

Suppose we write a list of the integral products of 7: 14, 21, 28, 35, 42, 49, 56, 63, 70, 77, 84, 91, and 98. I note in some cases that the tens digit minus twice the units digit is zero i.e. 21, 42, 63, 84. In some other numbers the tens digit minus twice the units digit is 7; i. e. 70, and 91. And in the remainder of the numbers above the tens digit minus twice the units digit is an integral product of -7; i.e. 14, 28, 35, 49, 56, 77, and 98.

In the case of numbers over 100, take all of the number except the units digit from which to subtract twice the units digit.

Examples: 344: $34-(2)(4)=26$ Ans: 344 is *not* evenly divisible by 7
644: $64-(2)(4)=56$ Ans: 644 *is* evenly divisible by 7

If the remainder from the intial subtraction is too large to be or not to be an obvious integral product of seven, the test may be applied to the remainder:

Example: 4816: $481-12=469$
$46-18=28$

The above may be done more compactly:

```
4816: 481
      12
      ---
      469
      18
      ---
      28    Ans: 4816 is an integral product of seven
```

Thus:

"If twice the units digit subtracted from the rest of the number leaves an integral product of 7, −7, or zero, the number is evenly divisible by seven."

The above does not seem too important as occasions for its use are not common. But I think it does appeal to those possessing a little intellectual curiosity.

WHAT LIES AHEAD IN SCIENCE EDUCATION

ARTHUR G. HOFF
Palm Springs Unified School District, Palm Springs, Calif.

More and better science education for all is the present and future need. If we consider a general aim of education, which may be stated, "efficient participation in a democratic social order," it is inconceivable that this aim can be achieved without comprehensive functional science education. That we are living in a scientific age is constantly brought to our minds through current discussion and writings on our "atomic age." Not only is science affecting and directing our physical lives, but in many ways it is becoming a way of life—a guide to intelligent living. A knowledge of natural laws, including those of physical and mental health, makes it possible for human beings to live within these laws and thereby achieve a richer life.

SCIENCE MINISTERS TO ALL GENERAL OBJECTIVES OF EDUCATION

Recently the writer observed a group of science teachers who were working on a state science curriculum program. They were attempting to select the objectives from the statements of the Education Policies Commission,[1] to which science made a special contribution. After several hours of deliberation it was decided that science ministered to all in this list. The same result may be found in attempting

[1] Statement of Objectives
(1) The Objectives of Self-Realization—the inquiring mind, speech, reading, writing, number, sight and hearing, health knowledge, health habits, public health, recreation, intellectual interests, esthetic interests, character.
(2) The Objectives of Human Relationship—respect for humanity, friendships, cooperation, courtesy, appreciation of the home, conservation of the home, homemaking, democracy in the home.

to analyze the cardinal objectives of education:[2] *Health, Command of Fundamental Processes, Worthy Home Membership, Vocation, Citizenship, Worthy Use of Leisure, Ethical Character.*

Educational Values of Science

Values of science may be classified into three major areas; namely, practical, disciplinary, and cultural. Considering the practical phase of science education we find that science is a basis for a large amount of modern progress in medicine, communications, industry, transportation, modern conveniences, and the like. Under the disciplinary values of science we can include methods of thinking such as scientific method and the scientific attitude. These disciplinary values are definitely transferable to other areas of study. Culturally, science is a basis for intelligent understanding and appreciation of modern life, its environment and accomplishments. This intelligent background eliminates superficial and fantastic concepts which were prevalent in the past and entirely too popular at the present time, illustrated by superman and the like. It promotes realistic and intelligent appreciations and understandings of the future possibilities of human endeavor.

Present Day Shortcomings of Science Education

The experience with servicemen during the war indicates that the schools were doing a fairly satisfactory job of science education. The last war was highly scientific and men needed a great deal of background in science in order to perform their responsibilities successfully. It was remarkable how quickly these men could be trained for these highly skilled and scientific responsibilities. This would not have been possible had not a good background been developed previously in our schools. In spite of the apparent satisfactory situation, our science education can and should be considerably improved.

Inadequate in Extent and Kind

For present day living a great deal more science than is now taught should be available for public school youngsters. Also the quality of science instruction should be greatly improved. There is little evidence to show that more intelligent living is achieved due to the science teaching which is taught today.

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(3) The Objectives of Economic Efficiency—work, occupational information, occupational choice, occupational efficiency, occupational adjustment, occupational appreciation, personal economics, consumer judgment, efficiency in buying, consumer protection.

(4) The Objectives of Civic Responsibility—social justice, social activity, social understanding, critical judgment, tolerance, conservation, social applications of science, world citizenship, law observance, economic literacy, political citizenship, devotion to democracy.

[2] Education Policies Commission, *The Purpose of Education in American Democracy*, National Education Association, Washington 1938.

Surveys show that biology is the only universally required subject. General science is required in only one half of the schools in California and Los Angeles County and only half of the schools in this area require any science for graduation. This indicates that one half of our high school graduates may go through the total education program without any science education at all. In a scientific age such as we have today this is apparently grossly inadequate. An adequate program should see that knowledge such as that offered in general science, biology, chemistry, physics, geology, and others should be required of all pupils before they leave school. The individual subjects as taught today are too narrow in scope. Pupils get only a small part of science knowledge which affects their lives.

Factual knowledge is stressed at the expense of functional principles. Unfortunately the influence of the war has caused a re-emphasis on factual science. Many science teachers are mistakenly emphasizing factual information as far down as the junior high school and are losing the proper perspective because of this.[3] There is too much mysticism and superstition and science ignorance still prevailing. This is evidenced by popular belief in Indian rain makers, faith healers, and effectiveness of deceptive advertising claiming scientific support.

Inadequately Prepared Teachers

A great deal of our science teaching at the present time is attempted by inadequately prepared teachers. This has at least two important consequences. First, a great deal of science misinformation results. Pupils learn many inaccuracies which subsequently need to be retaught. Secondly, poor methods of teaching cause lack of interest in science. Too many teachers employ the college type of teaching in their secondary schools which is too academic and overburdened with memorization of facts and laws without understanding. There is too much of the "page assignment and lesson hearing" type of teaching and not enough "doing." This results in a stereotyped, dull and nonfunctional type of science education.

Inadequate Science Instructional Materials

Although we are making rapid progress, too much science instruction material at the present time is too academic and factual and uninterestingly written. Modern instruction materials, which are prepared by experts are remedying this rapidly. Teacher prepared materials are often confusing, poorly coordinated and poorly graduated. These materials also tend to lack broadness and comprehensiveness. For instance, one 9th grade class spent a whole semester on magnet-

[3] Mr. H. E. Ahrens, Unpublished M.A. Thesis, 1948, Claremont College, Claremont, California.

ism. This obviously is too much time devoted to this area on that grade level, resulting in other areas being omitted.

Future Developments in Secondary Education

High Schools Free from College Requirements

The high school will be freed from college entrance requirements. This will make possible the formulation of a functional science program for the secondary school. Studies show that there is no significant relationship between high school subject study and success in college. It is found that motivation and habit of study are the greatest factors.[4] It appears that considerable progress is being made in this direction in freeing high schools from college domination, although at the present time it is largely in the proposal stage.

Vocational Training Projected Upward

There is a strong tendency at the present time to project vocational training upward into the junior college. This will make it possible to devote the high school years to general education. The larger areas of emphasis in the high school will probably be (1) Humanities, including English and languages (2) Social studies, including history, civics, and economics, (3) Industrial and fine arts activities, including woodworking, home science, and craft art, and music of all types, (4) Science-generalized, including the necessary mathematics to be taught with the science courses. There will probably be constants and variables within these larger areas.

Future Needs in Science Education

Improved Science Curriculum

A more extensive and well-planned elementary science school program is needed. This will permit greater science learning before reaching junior and senior high school. Science can be effectively taught in elementary school. Some social studies materials and laboratory literature may be replaced with science materials such as biographies of Edison, Currie, Bell, and Marconi. These may well replace stories of the Greek gods and fairy stories. Efficient instruction materials are now available and in the process of preparation. These materials should be scientifically graded as to difficulty and interest and should be a well-planned scheme avoiding duplication. Elementary school teachers should have more adequate training in science. Elementary science is more difficult to teach than more advanced sciences because a broad knowledge is necessary in order

[4] Hoff, A. G., "The Effects of the Study of High School Chemistry on the Success in College Chemistry," *Review of Educational Research*, 50: 539–542; March 1947.

A Suggested Secondary School Science Curriculum in a Pattern of General Education. The Science Curriculum Will Be Largely Required. Electives May Be Provided in Other Curricula. Guidance Activities Will Be Centralized in the Social Studies Curriculum with All Curricula Contributing

Grade	Communication & Literature	Social Studies	Industrial, Home and Fine Arts	Science & Mathematics	Physical Ed. & Health
7	Oral and written expression Literature	Suitable activities "Nations to the South"	a. Sewing b. Handicraft, woodwork, metal-work, plastics c. Art d. Music—voice & instru.	Immediate pers. prob. & simple understanding of phys. and community environment. Review and application of arith. fund.	Physical & recreational activities
8	Literature Oral and written expression	Suitable activities "The Orient"	More advanced activities in types mentioned for grade 7.	Wider social significance of science. Use of sci. for control of environment. Review and application of arith. fund.	Same as 7
9	Same (properly graduated)	Suitable activities "American History"	Graduated activities of type in grade 8	General biology Physiology & Health General Mathematics	Same as 8
10	Same as for grade 9 Modern Languages	"World History"	Woodworking Machine Shop Garage, Home science Art, Typing Music—Indiv. & group	Physical Science a. Emphasis on chemistry b. Geology c. Unit in math. needed in chemistry	Same
11	Same as for grade 10	"American History"	Advanced: Woodworking Machine shop Garage, Home science Music, Typing Art	Physical Science a. Emphasis on physics b. Meteorology c. Astronomy d. Aviation e. Math for physics	Same
12	Same as for grade 11	Sociology and Civics	a. Continuation of activities b. Family relations	General Science a. Psychology 1. Mental hygiene 2. Getting along with people b. Consumer science c. First Aid d. Driver education e. Safety	Same

to satisfactorily answer children's questions. In order to improve the science curriculum it is necessary to utilize to a greater extent the findings of investigations on science teaching. Instruction materials prepared by experts should be utilized and teachers should learn how to use them properly. Much of the poor science instruction is due to poorly made teacher instruction materials in the elementary school. Instruction materials in science should be prepared by experts in science education using teachers as consultants. In other words, teachers should experiment and try out the materials and help experts in making these more usable. This is a reversal of the present procedure of utilizing teacher curriculum committees with experts as consultants. Teacher curriculum committees should spend their time selecting the best available materials and learn how to use rather than try to prepare these materials themselves. The average teacher neither has the time nor the ability to prepare efficient materials. In addition the teacher should spend time and energy adapting efficiently prepared materials to local needs. As most science knowledge is universal, the adaptation to local needs is a minor problem.

Improved Junior High School Program

The junior high school program in science should be continuous and correlated with the elementary school program. It should be of a general type required five periods per week in each of the three junior high school years. Many junior high school series of science instructional materials are available. Many of these are correlated with elementary school series. In such a program the science knowledge at the end of the sixth grade can be equal to the amount now possessed at the end of grade nine, and the science knowledge at the end of grade nine can equal that now possessed by high school seniors.

Senior High School Science

The science courses in the senior high school should be of the generalized type, providing for a broad knowledge of the area. General courses should replace the now specialized offerings. If a comprehensive science program is provided throughout the elementary school and junior high school, it is possible to place the stress on biology in the 9th grade. This makes it possible to place major emphasis on chemistry in the 10th grade, and major emphasis on physics in the 11th grade. The 12th grade then may be reserved for a generalized science which may include psychology, mental hygiene, consumer education, driver education, safety, first aid and the like.

d. Driver education
e. Safety

Methods of Teaching

The large unit plan is an efficient technique for presenting science materials. It provides for flexible assignments with minimum essentials. It is generally accepted that the use of a single basic text, which is the best available, serves as the most efficient instruction material for the minimum essentials portion of the course.[5] Such a text should not be more than five years old, or preferably three. It should have abundant references for bright pupils. Multiple references have been found to be confusing to slow pupils.

The hour period, with reference books in the classroom, is considered the best program. Abolition of the double laboratory period is recommended. A laboratory should be injected at psychological moments. Pupil activity should be stressed and directed study techniques should be predominant. Generally, no study outside of class. However, voluntary study outside should be motivated. The guidance aspect of teaching should be emphasized. The teacher should be ever on the alert for special abilities. The application of science should be stressed to help pupils in occupational and vocational information. Guidance in the study and planning of a life's work should be correlated with the science program and social implications of science should be emphasized. The resources of audio-visual aids are more abundant in science than any other field, therefore they should be utilized and field trips should be used intelligently. More functional laboratory experiences and projects, such as familiarity with home appliances, landscaping, and floraculture should be incorporated in the program.

There should be greater use of science clubs and activities. These media stimulate interest in science and afford an enriched program which is more practical. More effective care for individual differences can be effected.

General Conclusions

We must progress slowly and cautiously. We should be content, but not satisfied, with the present status.

[5] National Society for Study of Education, 46th Year Book, Public School Publishing Co., Bloomington, Ill., 1947.

No man ever wetted clay and then left it, as if there could be bricks by chance and fortune.—PLUTARCH

Coin-holding bracelet, a recently patented invention, consists of a series of holders, each designed to hold one coin. Coins are engaged beneath a lip and held in place by a spring. The bracelet is ornamental, inexpensive to make, durable and practical.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

Late Solutions

2203. *Proposed by Alan Wayne, Flushing, New York.*

A cube with its edge m units long is painted red and then sliced into m^3 unit cubes. Find an algebraic formula for the number, n, of these unit cubes, each of which has precisely k red faces.

Solution by Adrian Struyk, Paterson, New Jersey

After being sliced the large cube has at its corners eight unit cubes, each with three red faces; it has along its edges $12(m-2)$ unit cubes, each with two red faces; it has on its faces $6(m-2)^2$ unit cubes, each with a single red face; and it has $(m-2)^3$ unpainted cubes inside. Thus the totality of unit cubes is

$$(m-2)^3+3(m-2)^2\cdot 2+3(m-2)\cdot 2^2+2^3. \tag{1}$$

Obviously the number of unit cubes with k faces red is given by the $(k+1)$th term in the expansion of $[(m-2)+2]^3$. Hence the required formula is

$$n={}_3C_k\cdot 2^k(m-2)^{3-k}.$$

Solutions were also offered by: W. R. Talbot, Jefferson City, Mo.; Max Beberman, Shanks Village, N. Y.; E. C. Rodway, Schumacher, Canada; V. C. Bailey, Evansville, Ind.; Prasert Na Nagara, College of Agriculture, Thailand; C. W. Trigg, Los Angeles City College.

2204. *No satisfactory solution was offered.*

2205. *Proposed by Michael Schwartz, Kingston, New York.*

If a line from vertex C of triangle ABC, bisects the median from A it divides the base, AB, in ratio 1:2.

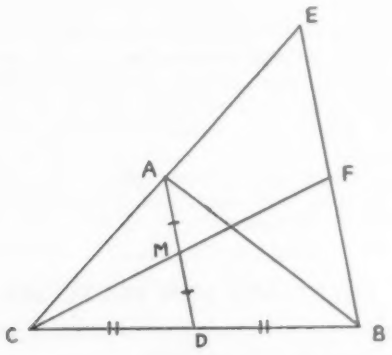
Solution by Aaron Buchman, Buffalo, New York

Through B draw BE parallel to median AD of triangle ABC. Let BE meet CA

extended, at E. Let M be the midpoint of median, AD. Let CM extended, meet BE at F.

At once, A is the midpoint of CE and F is the midpoint of EB. Therefore, CF and BA are medians of triangle EBC and divide each other in the ratio 1:2.

This problem is given as Ex. 5, page 64 of College Geometry by Altshiller-Court.



Other solutions were also offered by: Prasert Na Nagara, Thailand; L. L. J. Klosterman, Rochester, N. Y.; C. W. Trigg, Los Angeles City College; Max Beberman, Shanks Village, N. Y.; D. McLeod, Winnipeg, Canada; W. R. Talbot, Jefferson City, Mo.; Robert E. Horton, Los Angeles City College; E. C. Rodway, Schumacher, Canada; V. C. Bailey, Evansville, Ind.; David Rappaport, Chicago, Ill.; and the proposer.

2206. *Proposed by Norman Anning, University of Michigan.*

A zigzag from $O(o, o)$ to $P(1, p)$ to $Q(q, o)$ to $R(4, r)$ is made so as to have two right angles. If $p = 2 \cos A$, then $-r = 2 \cos 3A$.

Solution by V. C. Bailey, Evansville, Indiana

From similar triangles

$$\frac{p}{1} = \frac{q-1}{p} = \frac{r}{4-q}.$$

If $p = 2 \cos A$, then $q - 1 = 4 \cos^2 A$.

$$q = 4 \cos^2 A + 1$$
$$r = (4 - q)\ 2 \cos A$$
$$r = (4 - 4 \cos^2 A - 1)\ 2 \cos A$$
$$r = 2\ (3 \cos A - 4 \cos^3 A)$$
$$-r = 2 \cos 3A$$

Solutions were also offered by: Dwight L. Foster, Florida A & M College; Max Beberman, Shanks Village, N. Y.; E. C. Rodway, Schumacher, Canada; W. R. Talbot, Jefferson City, Mo.; Robert P. Hale, South Australia; Adrian Struyk, Paterson, N. J.; C. W. Trigg, Los Angeles City College; Aaron Buchman, Buffalo, N. Y.; Prasert Na Nagara, Thailand.

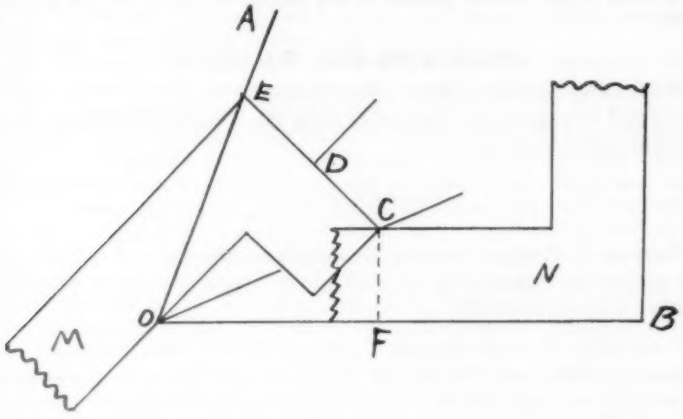
2207. *Proposed by Norman Anning, University of Michigan.*

Show how to trisect a given angle by use of two carpenter's squares.

Solution by V. C. Bailey, Evansville, Indiana

The carpenter's square used here has both arms the same width. The given angle is AOB. Place square, N, along one side of the angle. With marked points D, C on square M and $ED = DC = CF$, place square, M, so that one of its internal

edges passes through O and point, C, falling on an internal edge of square, N. Triangles EOD, COD, COF are congruent. Therefore, OD and OC trisect the given angle, AOB.



Other solutions were also offered by the following: Prasert Na Nagara, College of Agriculture, Thailand; C. W. Trigg, Los Angeles City College; W. R. Talbot, Jefferson City, Mo.

2208. *Proposed by Julius Sumner Miller, New Orleans, La.*

Show that the ratio of the distances described by a falling body during the $(n-1)$th and the nth seconds is $(2n-1)/(2n+1)$.

Solution by Cecil B. Read, University of Wichita, Wichita, Kansas

The statement is not in general true. If, however, the body is falling in a vacuum near the earth's surface, the usual relation $s=\frac{1}{2}gt^2$ gives the distance at the end of t seconds. During the $(n-1)$th second, the distance covered is equal to

$$\tfrac{1}{2}gn^2-\tfrac{1}{2}g(n-1)^2=\tfrac{1}{2}g(2n-1)$$

and likewise, during the nth second, the distance covered is

$$\tfrac{1}{2}g(n+1)^2-\tfrac{1}{2}gn^2=\tfrac{1}{2}g(2n+1)$$

yielding the ratio stated in the problem.

If, however, we assume air resistance proportional to the square of the velocity we may for convenience take the constant of proportionality to be k^2/g. The distance traversed in t seconds may be expressed as $s=g/k^2 \log \cosh kt$. Proceeding as before, the distance traversed during the $(n-1)$th second is

$$\frac{g}{k^2}\log\frac{\cosh Kn}{\cosh K(n-1)}$$

and during the nth second

$$\frac{g}{k^2}\log\frac{\cosh K(n+1)}{\cosh Kn}$$

which rather obviously fails to reduce to the ratio stated.

Other solutions were also offered by: Prasert Na Nara, Thailand; W. R. Talbot, Jefferson City, Mo.; V. C. Bailey, Evansville. Ind.; Adrian Struyk, Paterson, N. J.; Wm. Ware, Canby, Oregon; Rev. Brother Sidney, Bronx, N. Y.; C. W. Trigg, Los Angeles City College and Robert Hale, Kent Town, South Australia.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

PROBLEMS FOR SOLUTION

2221. *Proposed by Julius S. Miller, New Orleans.*

Deduce two trigonometric identities from the algebraic identity by making some appropriate substitution:

$$1+x+x^2+x^{n-1}=\frac{1-x^n}{1-x}.$$

2222. *Proposed by Norman Anning, University of Michigan.*

What points are common to all circles, $(x-a)(x-b)+y(y-c-a)=0$, where the number a is a parameter?

2223. *Proposed by Norman Anning, University of Michigan.*

In a plane quadrilateral $ABCD$, with $AC=$ and $\perp BC$, if squares are constructed on AB and CD as diagonals the squares have a vertex in common. Also squares on AD and BC as diagonals have a common vertex.

2224. *Proposed by Cecil B. Read, Wichita, Kansas.*

The base of an oblique cone is a circle with center, O, and vertex, P. Line OP makes an angle, θ with its projection in the plane of the base. What is the lateral area of the cone? (This is an unsolved problem, formerly given as 1807.)

2225. *Proposed by Roy Wild, Moscow, Idaho.*

Find a triangle in which the altitudes and the three sides are consecutive integers. (From Dickson's "History of the Theory of Numbers.")

2226. *Proposed by B. B. Libby, San Franciso.*

Construct the triangle given two sides and the area.

BOOK REVIEWS

A Course in General Chemistry, Semi-Micro Alternate Form, by William C. Bray, *Late Professor of Chemistry*, Wendell M. Latimer, *Professor of Chemistry*, and Richard E. Powell, *Associate Professor of Chemistry, all of the University of California.* Third Edition, first semi-micro edition. Cloth. Pages xiii+217. $5\frac{3}{4}''\times 8\frac{1}{2}''$. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.00.

The work of many fine teachers in thirty-five years of general chemistry at the University of California is represented in the latest edition of this well-known manual. Semi-micro techniques have been incorporated throughout, and are justified on the reasonable grounds of greater speed and neatness, wider coverage of material, and decreased long-run costs of chemicals and equipment. Several pages of illustrations of laboratory precautions, with discussion of safety measures, have been added. The emphasis on the principles of qualitative analysis is slightly greater than in earlier editions.

Like its predecessors, the present edition attempts, with success, I believe, to teach the fundamental principles of inorganic chemistry by means of a series of well-constructed and well-arranged laboratory exercises. Correlation of these with the lecture material is very close, and references to both the *Principles of Chemistry*, by Hildebrand, and the *Reference Book of Inorganic Chemistry*, by

Latimer and Hildebrand are frequently given. The general plan is designed to make the student think out his own answers logically; specific questions and problems are given to lead him on. Such a burden of thought may be too much for the poorer students, but the rest, especially those with a natural scientific bent, cannot fail to prosper. Optional problems for the better students should interest and encourage their progress in chemistry.

The first Section demonstrates fundamental concepts in chemistry and starts the student immediately on serious laboratory work with analysis and titration. Section II covers ionic theory and equilibrium, and Section III the systematic study of ionic reactions in aqueous solution. In this way, the manual slowly and thoroughly develops the principles of general qualitative schemes of analysis, with experimental work on the properties of electrolytes, acids and bases, reversible reactions and equilibrium, oxidation and reduction, and the specific properties of the more important cations and anions. In the final Section the separations are studied in terms of chemical equilibrium; the discussions, with graphs, of solubilities are particularly good. The student is encouraged to develop analytical schemes based on these principles. Parts of the usual qualitative analysis scheme are discussed, as well as some experimental techniques, especially those for dissolving solid samples.

The manual is designed for a two-term course in general chemistry. An excellent outline of the course is given and will be found helpful by every teacher who uses the book. A few changes or deletions are suggested in the otherwise somewhat rigid schedule. Two appendices, one on general laboratory techniques and one on the preparation of reagents, should be extremely useful to teacher and student alike.

Some readers may object to certain isolated points (e.g. the definition of *molality*, p. 40; the oblique reference to back titration, p. 45; or the Nernst equation for the H_2-H^+ couple, p. 111), but as a whole the book is very well organized and clearly written, and is to be highly recommended.

WILLIAM J. ARGERSINGER, *Assoc. Professor*
Department of Chemistry
University of Kansas

INTRODUCTION TO SEMIMICRO QUALITATIVE CHEMICAL ANALYSIS, by Louis J. Curtman, *Emeritus Professor of Chemistry, The City College of New York*. Revised edition. Cloth. Pages xvi+391. $5\frac{1}{2}'' \times 8\frac{1}{4}''$. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.50.

The revised edition of Professor Curtman's standard semimicro manual introduces changes and revisions chiefly in the laboratory section, and there primarily in the analysis of anions and the removal of interfering anions before cation analysis. Doubtless any improvements in anion analysis will be welcomed by all teachers of introductory qualitative analysis; especially welcome will be these improved anion techniques based on a large amount of new research by the author and his research students, notably Mr. N. Gaylord.

Part I presents a well rounded discussion of the theoretical bases of qualitative analysis. An introduction to coordination theory leads to a general discussion of acids and bases according to the Brönsted concepts. The subject of chemical equilibrium is treated in detail, with separate sections on general theory, weak acids, solubility products, complex ions, hydrolysis, and the solution of sulfides in acids. Part II describes the properties and reactions of the common cations and anions, which are then well illustrated in the preliminary experiments in the laboratory section. Part III is a brief discussion of types of calculation used in analysis, and Parts IV and V contain the experimental work and general schemes of analysis for metal ions and anions. Part V, which deals with the systematic analysis of anions and the removal of interfering anions for cation analysis, is distinctly improved in both content and presentation in the new revision.

An assignment schedule, suggested lecture topics, laboratory techniques and

devices, and tables of solubilities, solubility products, and general properties of inorganic compounds are all included in the extended appendix. The assignment schedule is arranged for six hours of laboratory work a week in a fourteen week term; it may be reduced for classes with less laboratory time by decreasing the amount of work done on anions and general unknowns.

The book is carefully and clearly written, the illustrations are pertinent and helpful, and errors are very few.

WILLIAM J. ARGERSINGER, JR.

BOTANY—AN INTRODUCTION TO PLANT SCIENCE, by W. W. Robbins and T. E. Weier, *both Professors of Botany in the College of Agriculture, University of California.* Cloth. Pages ix plus 480. 490 illustrations. 18×24 cm. 1950. John Wiley & Sons, Inc., New York. Price $5.00.

The large format of this new botany text was chosen by the authors specifically to permit free use of large illustrations, and they selected 490 for use in the text. Most of the illustrations are used in such a way as to fit in with the reading matter of the text, which is set in double columns to facilitate the usage of illustrative material in such a manner.

The first two chapters of this book, which is designed explicitly as a beginning botany text for college courses, show the relationship of botany to other fields of study and orient the student to the importance of the study he is about to begin. The text is written at an appropriate readability level, with important points stressed and repeated from time to time to assure their understanding. Very recent and controversial concepts are purposely omitted to prevent confusion.

Teachers of botany should give this new text close examination. No matter what text they are now using, Robbins and Weier's new book may be its better, both in style and format.

GEORGE S. FICHTER
Miami University
Oxford, Ohio

GENERAL BIOLOGY, by Gairdner B. Moment, *Professor of Biology, Goucher College.* Second Edition. Cloth. Pages xvi plus 680. 483 figures. 15.5×24 cm. 1950 D. Appleton-Century Company, Inc., New York. Price $5.00.

This is a revised edition of a college biology text, first published in 1942. This new edition gives emphasis to scientific evidence and includes all the new discoveries made since the first publication. Historical background is given for discoveries wherever possible to give understanding of a concept the proper depth for appreciation. At the end of each chapter there is a list of references, divided into basic classics and contemporary readings.

Chapter headings tell the contents of the book better than any lengthy description: Foundations of Biology, Classification of the Living World, Universal Characteristics of Living Things, Survey of Plant Types and Ways of Life—followed by chapters on plant nutrition, metabolism, reproduction, behavior and growth, Relationships of Plants and Animals, Animal Types—followed by chapters on animal protection, support, motion, nutrition, respiration, excretion, nervous coordination and sense organs, behavior, hormones, reproduction, development, heredity, Evolution, and History of Life on this Planet. At the end of the book there is a listing of the plant and animal phyla and an extensive glossary of terms.

The book is comprehensive and well illustrated. Throughout the text new words, which can be looked up in the glossary, are set off in boldface type, and each chapter is outlined for ease of use. Colleges and universities with courses in biology will do well to examine this text.

GEORGE S. FICHTER

TEACHING BIOLOGY FOR APPRECIATION, by Alfred F. Nixon, Ed. D. Cloth. Pages 143. 16 plates. 13.5×20 cm. 1949. Chapman and Grimes, Boston. Price $3.00.

Here is a discussion of the part biology plays in the lives of all of us—and how to teach it as an interesting subject rather than an uninteresting, factual science. It's a book for the biology teacher, an aid to developing in students an appreciation of biology as it relates to other subjects. Presenting information alone is insufficient. That information must also appeal to the student. It must arouse in each student some emotion and relate somehow to his other fields of study—the social studies, art, and literature.

First of all, the author defines "appreciation." Appreciation, he says, "involves both intellectual and emotional elements . . . a sensitive awareness to and perception of the importance or utility of information in its relation to other fields and in the development of attitudes and tastes." A teacher should give his students an opportunity to express this appreciation.

The author devotes a section each to demonstrating the significance of biology in art, literature, and social studies, and he gives suggestions as to how these studies can be brought into the biology classroom. This is certainly a book which all teachers of biology should examine. It is a plea to revamp present-day biology courses so that they play a greater importance in preparing students for living.

GEORGE S. FICHTER

AN INTRODUCTION TO PROBABILITY THEORY AND ITS APPLICATIONS, by William Feller, *Professor of Mathematics at Cornell University*. Volume one. Cloth. 16×23.5 cm. pages xii+419. 1950. John Wiley and Sons, Inc. 440 Fourth Avenue, New York 16, N. Y. Price $6.00.

Within the past few years several books have appeared which treat probability, either as a separate subject or in connection with statistics, from a rigorous mathematical viewpoint. In common with most such texts this book requires a knowledge of at least such topics as the integral calculus, differential equations, and matrix theory. Although the mathematical development is rigorous, the question of practical applications is not ignored. Many illustrations of such applications are presented.

There are approximately 350 problems (with answers) with widely varying degrees of difficulty. A considerable portion of the material, in fact over twenty-five per cent, is starred as not essential in order to follow the main discussion. Indicative of material beyond the usual somewhat elementary topics, one might mention some chapter titles: Random variables, expectation; Laws of large numbers; Integral valued variables, generating functions; Recurrent events; Random walk and ruin problems; Markov chains.

Anyone seeking a text for a course in mathematical probability or a good reference work for the college library should by no means overlook this book.

CECIL B. READ
University of Wichita

THE ANATOMY OF MATHEMATICS, by R. B. Kershner, *Applied Physics Laboratory, The Johns Hopkins University*, and L. R. Wilcox, *Associate Professor of Mathematics, Illinois Institute of Technology*. Cloth. Pages xi+416. 16×23.5 cm. The Ronald Press Company, New York, N. Y. 1950. Price $6.00.

This book is an attempt to present some of the ideas of modern mathematics, considered primarily as the study of consequences of systems of axioms. It is technically true, as the authors state, that "the only prerequisites for reading this book are the desire to start and the perseverance to finish"; nevertheless it is doubtful if the book will be satisfactorily read by anyone without some training in the field—perhaps a minimum of two years of college mathematics.

Without casting any reflection upon the other portion of the book, the reviewer felt that the first three chapters presented one of the best introductory statements that it has been his privilege to read. From this point, the book requires

careful study to grasp the many concepts. Throughout the book one finds "projects" designed to help the reader test his mastery of the material. An appendix contains solutions, partial in some cases, of these.

It would seem that there is no book readily available which can approach the broad coverage of this text. Some idea of the extent of the material can be grasped by quoting a few chapter headings: The Postulational Method; Groups; The Positive Integers; Finite Sets; Inductive Definition and the Principle of Choice; Isomorphism; The Real Numbers; Fields. With such wide range the authors have wisely chosen a careful and thorough presentation of a relatively small amount of material. At various points suggestions for further study are made.

The symbolism used by the authors might well be classed as "standard"; nevertheless, one not familiar with modern mathematical notation will find one disadvantage in attempting to use this book as reference material for a single topic—the necessity to dig through a considerable amount of earlier material in order to understand the notation.

CECIL B. READ

MAN'S PHYSICAL UNIVERSE, A Survey of Physical Science for Colleges, by Arthur T. Bawden, *Stockton College, Stockton, California.* Third Edition. Pages xv+822. Macmillan 1950. Price $4.75.

I have known this book for at least ten years (the first edition was 1937), and if "alien" forces had not interfered I would have used it ere this. *This is a very excellent book.*

It is intended as a text for survey courses in physical science. It is admirably suited to the *general education* scheme which currently prevails.

The exposition is clear and essentially free of glaring errors. Pedagogically it is eminently sound. It is not an easy book but will well repay both student and teacher the industry it demands.

The author anticipates a 1960 edition. There will undoubtedly be much new scientific progress to report. We would hope, too, that the socio-centric implications can be more happily pointed to. But the author need not anguish himself over improvements in exposition or format or teachability.

This book can be recommended without reservation.

JULIUS SUMNER MILLER
Dillard University
New Orleans, Louisiana

PHYSICS: A TEXTBOOK FOR COLLEGES, by Oscar M. Stewart, *University of Missouri.* Fifth Edition by Newell S. Gingrich, Professor of Physics, University of Missouri. Pages v+726. Ginn & Co. 1950. Price $5.00.

This fifth edition of a widely known and widely used text needs little if any comment. The contents and order are fairly standard. The exposition is good; the mathematics a minimum; the illustrations and problems well done. Answers are included. Although substantially an elementary text rigor is not altogether wanting. The MKS system is, happily, included, and the cgs is still retained.

Nearly all the problems appear to be rewritten. In this regard I feel a personal loss since in the earlier editions I had occasion for considerable exchange of notes with Professor Stewart regarding certain problems.

When the circumstance permits I shall return to using this text. I do not believe that I could give it higher recommendation.

JULIUS SUMNER MILLER

SATURATING CORE DEVICES, by Leonard R. Crow, *Director of Research and Development, Universal Scientific Co., Inc.* Pages xii+373. The Scientific Book Publishing Company, Vincennes, Indiana. Price $4.20.

This book, says the author in preface, is intended to acquaint the elementary

student in electric sciences with electric phenomena not to be found conveniently collected elsewhere. Its chief concern is obviously saturable core magnetic devices. Although for the benefit of the "elementary" student, a reader needs to bring to the book a goodly background in basic electricity and magnetism.

Although intended as a textbook I am of the opinion that it would serve better as a handbook atop an engineer's desk.

The diagrams are clear and the exposition reasonably good. The printing is lithoprint by Edwards Brothers. A brief bibliography is included.

JULIUS SUMNER MILLER

REFLECTIONS OF A PHYSICIST, by Percy W. Bridgman. Pages xii+392. Philosophical Library 1950. $5.00.

In this Bridgman volume we have assembled twenty-two "essays" all of which (save three) have been published elsewhere before. They were written or delivered as addresses in the last two decades. The shortest is 3 pages, one or two 30-odd pages; the average length about 15 pages. Any one thus makes reading at one sitting an easy matter.

These essays deal with modern physics and its social and political implications. Although they have appeared over a span of some 20 years they make a surprisingly unified collection. They are grouped under four general headings thus:

Group I. General Points of View
Group II. Applications to Scientific Situations
Group III. Primarily Social
Group IV. Specific Situations

It is to be expected that some devotion be given to the subject of operational analysis, and Bridgman elegantly handles the criticism of the adequacy of the operational method made by Lindsay. The discussion of the Uncertainty Principle is beautifully done. The essay entitled *Permanent Elements in the Flux of Present-Day Physics*, although 20 years old, is very stimulating and provocative. The essay on *Statistical Mechanics and the Second Law of Thermodynamics* is exciting to read. Regarding the essay *On the Nature and the Limitations of Cosmical Inquiries*, all I can say is that I have read it three times and each time find a new impulse given to my thinking. *The Struggle for Intellectual Integrity* is even more appropriate today than when it first appeared in 1933.

The essays "Primarily Social" *need to be read*, for the last 5 years have put a heavy hand upon the physical scientist in this matter of social responsibility.

This book would provide good exercises for seminar groups in academic quarters. It is instructive and illuminating for the layman. All the essays lead inevitably to serious discussion. And where can one get intellectual stimulation for so little cost?

JULIUS SUMNER MILLER

BOOKS AND PAMPHLETS RECEIVED

CONSERVATION OF NATURAL RESOURCES, by Guy-Harold Smith, *Professor and Chairman, Department of Geography, The Ohio State University, Columbus, Ohio.* Cloth. Pages xii+552. 18×24 cm. 1950. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.00.

DYNAMIC PLANE GEOMETRY, by David Skolnik, *Chairman, Department of Mathematics, Central Commercial and Technical High School, Newark, New Jersey* with the Editorial Assistance of Miles C. Hartley, *Assistant Professor of Mathematics, Chicago Undergraduate Division, University of Illinois.* Cloth. Pages xii+289. 18×24.5 cm. 1950. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $2.56.

THE PHYSICAL SCIENCES, Revised Edition, by George S. Eby, *Stockton Junior College, Stockton, California;* Charles L. Waugh, *Richmond Union High School,*

Richmond, California; Herbert E. Welch, *Stockton Junior College, Stockton, California;* and Burdette H. Buckingham, *Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Maryland.* Cloth. Pages vi+536. 18×25 cm. 1950. Ginn and Company, Statler Building, Boston 17, Mass. Price $3.36.

BASIC MATHEMATICAL ANALYSIS FOR JUNIOR AND SENIOR COLLEGES, by Glenn H. Ayre, *Professor of Mathematics and Director of General College Division, Western Illinois State College, Macomb, Illinois.* Cloth. Pages xvi+584. 1950. McGraw Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $5.00.

THE PRIVATE LIFE OF THE PROTOZOA, by Winifred Duncan, *Author of "Webs in the Wind."* Cloth. Pages ix+141. 15×23 cm. 1950. The Ronald Press Company, 15 E. 26th Street, New York 10, N. Y. Price $3.00.

MATHEMATICS OF RELATIVITY, by G. Y. Rainich, *Professor of Mathematics, University of Michigan, Ann Arbor, Michigan.* Cloth. Pages vii+173. 14.5×23 cm. 1950. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y. Price $3.50.

FUNDAMENTALS OF THE CALCULUS, by Donald E. Richmond, *Professor of Mathematics, Williams College, Williamstown, Massachusetts.* Cloth. Pages xi+233. 14.5×23 cm. 1950. McGraw Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $3.00.

MATHEMATICAL SNAPSHOTS, by Hugo Steinhaus, *Professor of the Calculus of Probability and Mathematical Statistics in the University and Polytechnicum in Wroclaw, Poland.* Cloth. Pages vi+266. 13.5×21.5 cm. 1950. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $4.50.

PROBABILITY AND THE WEIGHING OF EVIDENCE, by I. J. Good, M.A., Ph.D., *Former Lecturer in Mathematics at the University of Manchester, England.* Cloth viii+119. 15.5×22.5 cm. 1950. Hafner Publishing Company, 31 E. 10th Street, New York 3, N. Y. Price $3.00.

STRUCTURAL CARBOHYDRATE CHEMISTRY, by E. G. V. Percival, D.Sc., Ph.D., F.R.I.C., *Reader in Chemistry, University of Edinburgh.* Cloth. Pages viii+246. 13.5×21 cm. 1950. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $5.50.

LABORATORY GUIDE FOR THE PHYSICAL SCIENCES, Revised Edition, by George S. Eby, *Stockton Junior College, Stockton, California;* Charles L. Waugh, *Richmond Union High School, Richmond, California;* and Herbert E. Welch, *Stockton Junior College, Stockton, California.* Paper. Pages vii+164. 18.5×26 cm. 1950. Ginn and Company, Statler Building, Boston 17, Mass. Price $1.28.

VITALIZED CHEMISTRY (in Graphicolor), Revised Edition, by Russell T. Des Jardins, *Department of Chemistry, Middletown Collegiate Center, Middletown, New York.* Paper. Pages iv+378. 11.5×18.5 cm. 1950. College Entrance Book Company, 104 Fifth Avenue, New York 11, N. Y. Price 75 cents.

EXPERIMENTING WITH NUMBERS (Teacher's Manual for Use with Beginners) by Catherine Stern. Paper. 107 pages. 15.5×23 cm. 1950. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price 60 cents.

UNITED STATES CIVIL DEFENSE, Executive Office of the President, National Security Resources Board. Paper. Pages v+162. 13.5×23 cm. 1950. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 25 cents.

THE TEACHING OF SCIENCE IN PUBLIC HIGH SCHOOLS, by Philip G. Johnson, *Specialist for Science Division of Elementary and Secondary Schools.* Bulletin 1950, No. 9. Pages viii+48. 14.5×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 20 cents.

KNOW YOUR CAPITAL CITY, by Mary Willcockson, *Associate Professor of Elementary Education, Miami University, Oxford, Ohio.* Bulletin 1950, No. 18. Pages vi+39. 14.5×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 20 cents.

CORE CURRICULUM IN PUBLIC HIGH SCHOOLS, AN INQUIRY INTO PRACTICES, 1949. Bulletin 1950, No. 5. Pages iv+32. 15×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 15 cents.